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Make Castings for Railroads

Modern Foundry Designed, Erected and Equipped to Meet Part of the Demand for Steel Castings Incident to too Severe Operating Conditions which Characterize Rail Transportation

BY PAT DWYER

MANY factors are responsible for the wonderful development of the railroad systems of the United States. Due credit has been accorded on innumerable occasions to the mechanical and financial genius of those who projected, built and operated steam railway lines that today compirse practically two-fifths of the total railroad mileage of the world. Not so much has been heard to the foundrymen who met successfully the ever increasing and difficult specifications for castings forming part of improved equipment. Between the earliest days in the history of railroads when everything was in the most primitive condition, and the immense development of traffic of recent years, steady progress has been made while railroad students have applied themselves to the solution of the problem of how the increasing traffic could be handled most expeditiously and at the same time economically.

One of the most potent suggestions tending to reduce expenses is that the rolling stock shall have greater capacity and in that way reduce the proportion of dead weight carried. As a result, rails have been made heavier, roadbed more durable and everything entering into railroad construction more costly. Not long since 12 tons constituted a freight car load. At present maximum carloads for certain commodities range from 40 to 60 tons and in some instances, such as coal to 100 tons. Locomotives have been increased in weight

FIG. 1—MOLDING AND POURING IS ALL DONE IN ONE BAY OF THE FOUNDRY, SERVED BY ONE 25-TON OPEN-HEARTH AND ONE 3-TON ELECTRIC FURNACE

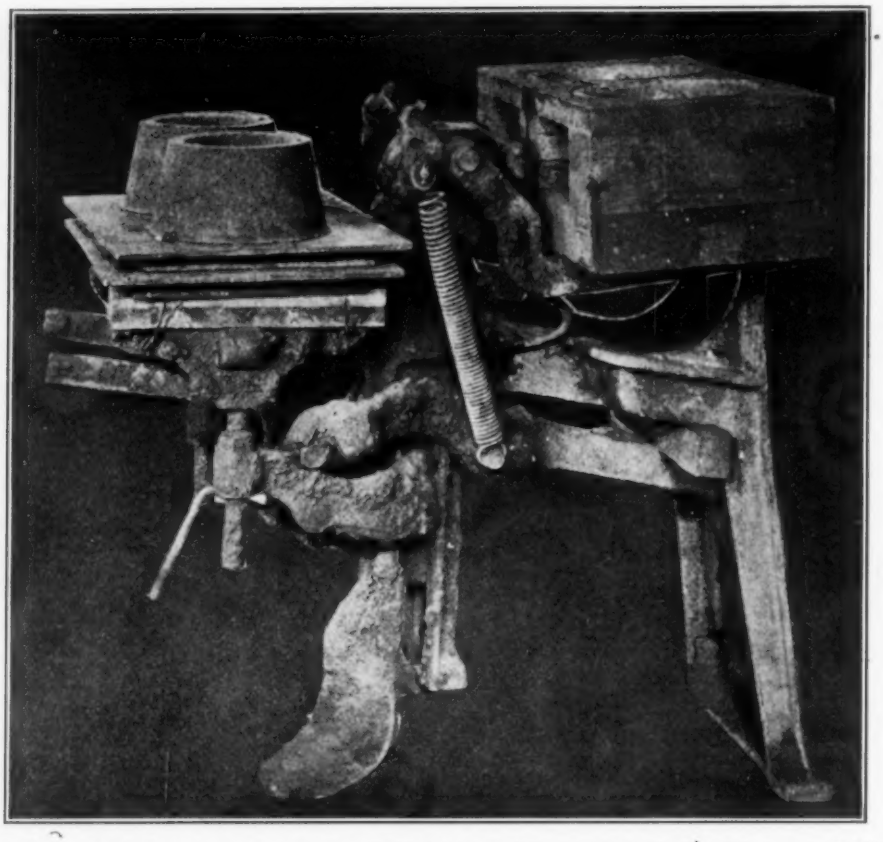

FIG. 2—POURING CUP CORES ARE TURNED OUT AT THE RATE OF 700 A DAY BY ONE MAN ON A HAND JOLT ROLLOVER MACHINE

from 50,000 pounds to 400,000 pounds and the limit has not yet been reached. Instead of the 50 and 60-pound rails used a few years ago, railroads now employ 90 and 120-pound rails. Former bridges were designed to withstand a live load of 3500 pounds per lineal foot. Bridges built recently are designed to support a live load of at least 7000 pounds per lineal foot.

In consequence of the foregoing conditions, practically all castings formerly made from cast iron have been replaced in modern railroad construction with castings made from steel or malleable iron.

While on the subject of railroad history it is interesting to note that one of the earliest railroads in this country was placed in operation in New York. In 1826 the State of New York chartered the Mohawk & Hudson railroad to carry freight and passengers from Albany to Schenectady, a distance of 17 miles. Work was begun in 1830 and the road was opened for travel in 1831. One method of visualizing the growth and expansion of the railroad industry is to compare this little infant with the husky giant into which it has developed as exemplified by the Twentieth Century Limited which with its daily run of 963 miles in 18 hours between New York and Chicago is claimed to be a greater number of miles run at a higher speed than by any other train in the world.

Located at Watervliet

At one time or another and in one way or another, New York state has had a great deal to do with projection, financing, operating and development of railways. Therefore, it seems appropriate that one of the largest steel foundries in the country specializing in railroad castings should be located at Watervliet close to the right of way of the little, old pioneer track that at one time connected Albany and Schenectady. The Adirondack Steel Foundries Corp., a subsidiary of the Dominion Foundries & Steel, Ltd., Hamilton, Canada, about 2 years ago erected and equipped a large modern steel foundry on a 31-acre site on the outskirts of the town and paralleling the main line of the Delaware & Hudson railroad.

Suitable spurs serve to convey all the raw material in and all the finished castings out of the plant easily and quickly. The foundry has a capacity of 400 tons of electric and 1200 tons of open-hearth steel castings per month.

The foundry building 160 x 400 feet is a self contained unit under one roof, but for convenience in operating, it is separated into three main divisions by rows of steel columns that support the roof and

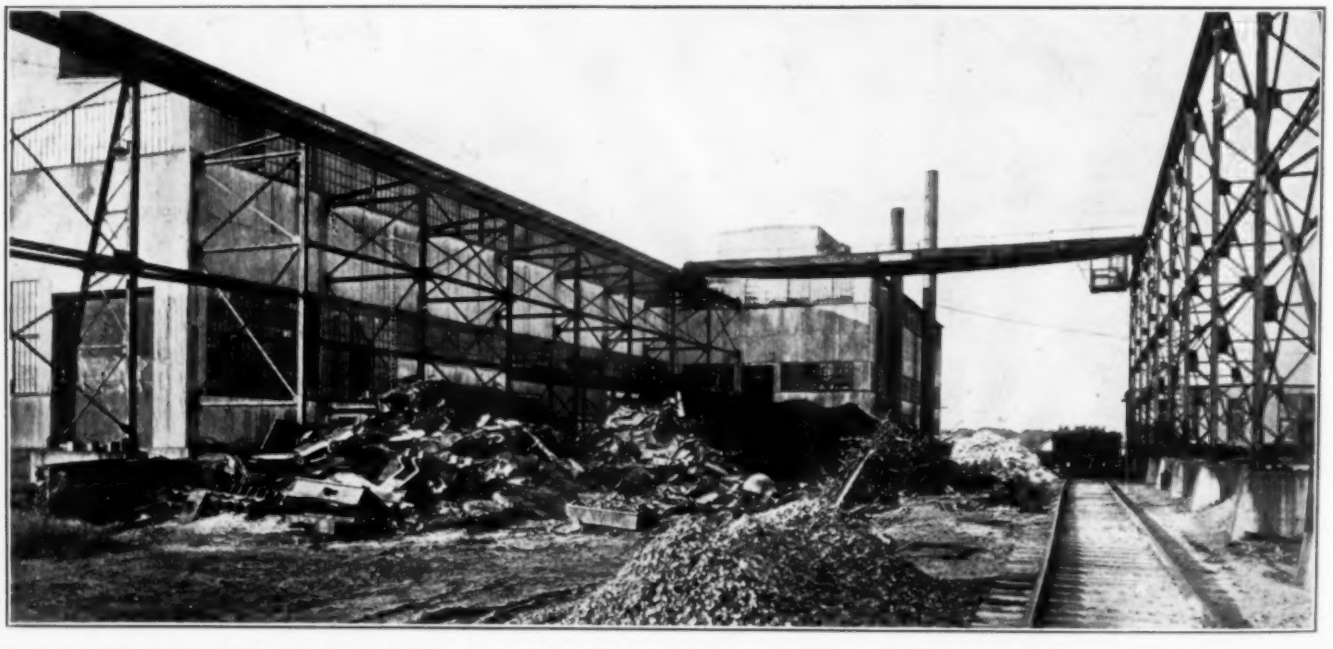

FIG. 3—THE STOCK YARD IS SPANNED BY A 7½-TON CRANE WHICH UNLOADS RAILROAD CARS, BREAKS SCRAP AND LIFTS THE CHARGING PANS ON TO THE BUGGIES WHICH SERVE THE OPEN-HEARTH FURNACE

also the crane runaways. The molds are made, poured and shaken out in the first of these divisions. The second division houses the sand storage, the coreroom and a general repair shop. The third bay is devoted entirely to cleaning, chipping, inspecting, testing and shipping the castings.

The location of the electric furnace and the open-hearth furnace may be noted in Fig. 1. The electric furnace made by the Pittsburgh Electric Furnace Corp., Milwaukee, is situated close to the outside wall in the molding bay between the green and dry-sand floors, the electric furnace has a rated capacity of 3 tons per heat, but on occasion has melted as high as 6 tons. A 25-ton, open-hearth furnace with all its auxiliary equipment is housed in a building adjoining the main foundry structure and open on the foundry side. It is oil fired of the stationary type charged on what is technically known as the *front* by an electrically operated charging machine and tapped on the *back* through a spout which extends beyond the columns and delivers the metal into a ladle suspended from one of the cranes which span the molding bay.

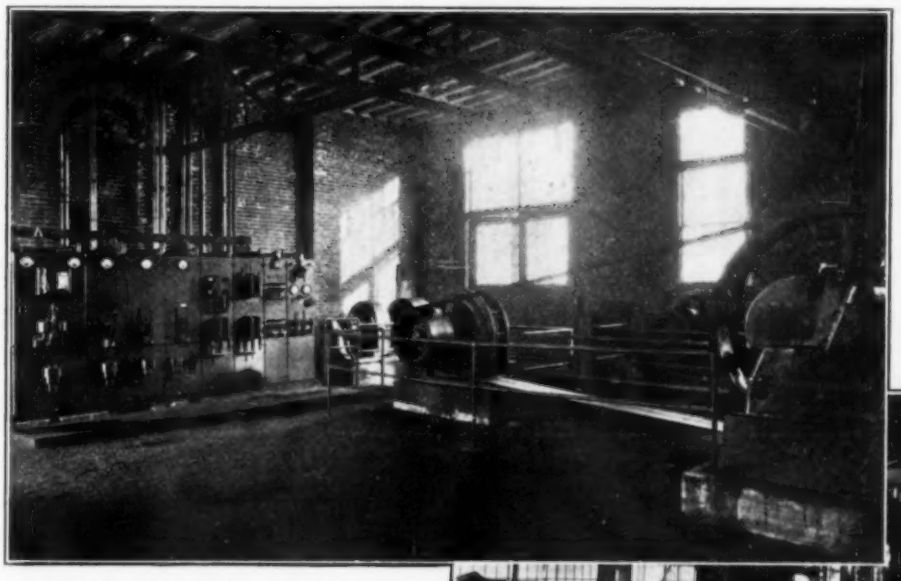

FIG. 4—CONTROL PANEL AND ONE OF THE COMPRESSORS IN THE POWER HOUSE

Steel Frame Construction

The foundry building is of steel frame construction, covered with corrugated, zinc coated sheets. Three rows of windows encircle the building and furnish ample light. One row commencing about 4 feet from the ground and extending upward for 10 feet; a second row extending down from the eaves approximately the same distance and a third row extending the full length on both sides of the three monitor roofs, one above each bay. The high roof and ample lighting facilities are illustrated in Fig. 1. The top of the crane runaway is 24 feet above the floor level and the columns extend upward an additional 10 feet to support the roof, which is formed of gypsum tile. It is claimed that this material is a non-conductor of heat and cold and also that it is impervious to moisture.

The stock yard shown in Fig. 3 is spanned by a 7½-ton electric traveling crane made by the Shaw Electric Crane Co., Muskegon, Mich. this crane is employed to unload all the material for the furnaces as it arrives on railroad cars and afterward is employed in breaking the scrap, and to load the charging pans and lift them onto the truck which conveys them into the space before the furnaces. The platform leading to the charging floor is shown near the center and under the left crane runaway. Cast-steel, charging pans are used for charging the open-hearth furnace. They are provided with the usual attachment at the end to engage the end of the charging machine ram which picks them off the car, pushes them into the furnace, rolls them over, dumps the charge on the hearth and then withdraws them and returns them to place once more on the buggies. The electric furnace is charged by hand. The material is loaded in pans in the stock yard and brought into the foundry on buggies running on a narrow gage track. This track extends to the cleaning and chipping room and serves to convey scrap, gates and sink heads to the furnaces.

Electric current for the furnace and also for the cranes and other appliances was furnished by the Cohoes Light & Power Co. It comes in over high power lines at 13,000 volts and is stepped down to 110 volts in three Westinghouse oil insulated, self-cooled single phase transformers located close to the power house. A direct current generator, operated by a 225-horsepower induction motor, supplies current for the cranes and other equipmeet of a similar character. Two 150-horsepower motors drive two compound air compressors manufactured by the Bury Compressor Co., Erie, Pa., with cylinders 10 x 12 and 10 x 12 respectively.

The main switch panel and one corner of the interior of the power house are shown in Fig. 4. Other equipment in the same building, but not shown, includes motor driven pumps for delivering oil to the open-hearth furnace, annealing ovens ladle heaters and core ovens. The oil is stored in five tanks, each with a capacity of 16,000 gallons, or a storage capacity for the five of 80,000 gallons. It is pumped to the foundry through a 3-inch main line which feeds several smaller lines inside the foundry building. Compressed air from the same station is delivered through a 6-inch main line. It is employed in the foundry for operating molding machines, door hoists and various

FIG. 5—THE ANNEALING OVEN IS SHOWN TO THE RIGHT AND ONE OF THE WELDING STATIONS ON THE LEFT—THE DEPRESSED TRACK WHERE CASTINGS ARE LOADED IS SHOWN IN THE RIGHT FOREGROUND

pneumatic tools in the chipping and cleaning room, including sandblast and dust arrester devices.

Taking the three parallel bays of the foundry in their relation to the position of the furnace, the first to engage attention is the molding bay shown in Fig. 1. It is divided roughly into two floors, one for green sand molds and one for those made in dry sand. Adequate lifting facilities are afforded by two 25-ton electric traveling cranes supplied by the Shaw Electric Crane Co., and five jib cranes, three on one side of the bay provided with air hoists made by the Curtis Pneumatic Machinery Co., St. Louis, and two on the opposite side of the bay provided with 3-ton electric hoists made by the Shepard Crane & Hoist Co., Montour Falls, N. Y. The traveling cranes are provided with auxiliary hoists usually employed for dumping ladles, pulling oven cars and other comparatively light work of a similar character.

The flasks used on the green sand floor were supplied by the Truscon Steel Co., Youngstown, O. On account of the exceptionally severe service to which flasks employed for dry sand molding are subjected, they are made of cast steel heavily ribbed and reinforced as shown in the typical example resting on the oven car in the foreground Fig. 1.

Molds are dried in two ovens each 16 feet wide, 20 feet long, 10 feet high. These ovens are situated one on either side of the molding bay in such a manner that one projects into the building housing the open-hearth furnace and the other into the center bay. Instead of the usual wheels the oven cars travel back and forth on a series of 6-inch ball rollers moving in suitable V-grooves that serve for the usual rails. The cars are made up of several sections and in that manner are more flexible than a car all in one unit. Each section may be handled independently, or if necessary, all sections may be clamped together and the entire car handled as one. The cars are hauled back and forth by a cable reeved through a sheave anchored in the floor and through another sheave anchored at the back of the oven floor. The free end of the cable is attached to the hook of one of the cranes. One oven is fired with oil and the other with coke. Each fuel presents advantages under certain circumstances, but no records are available to determine which is the more economical over an extended period.

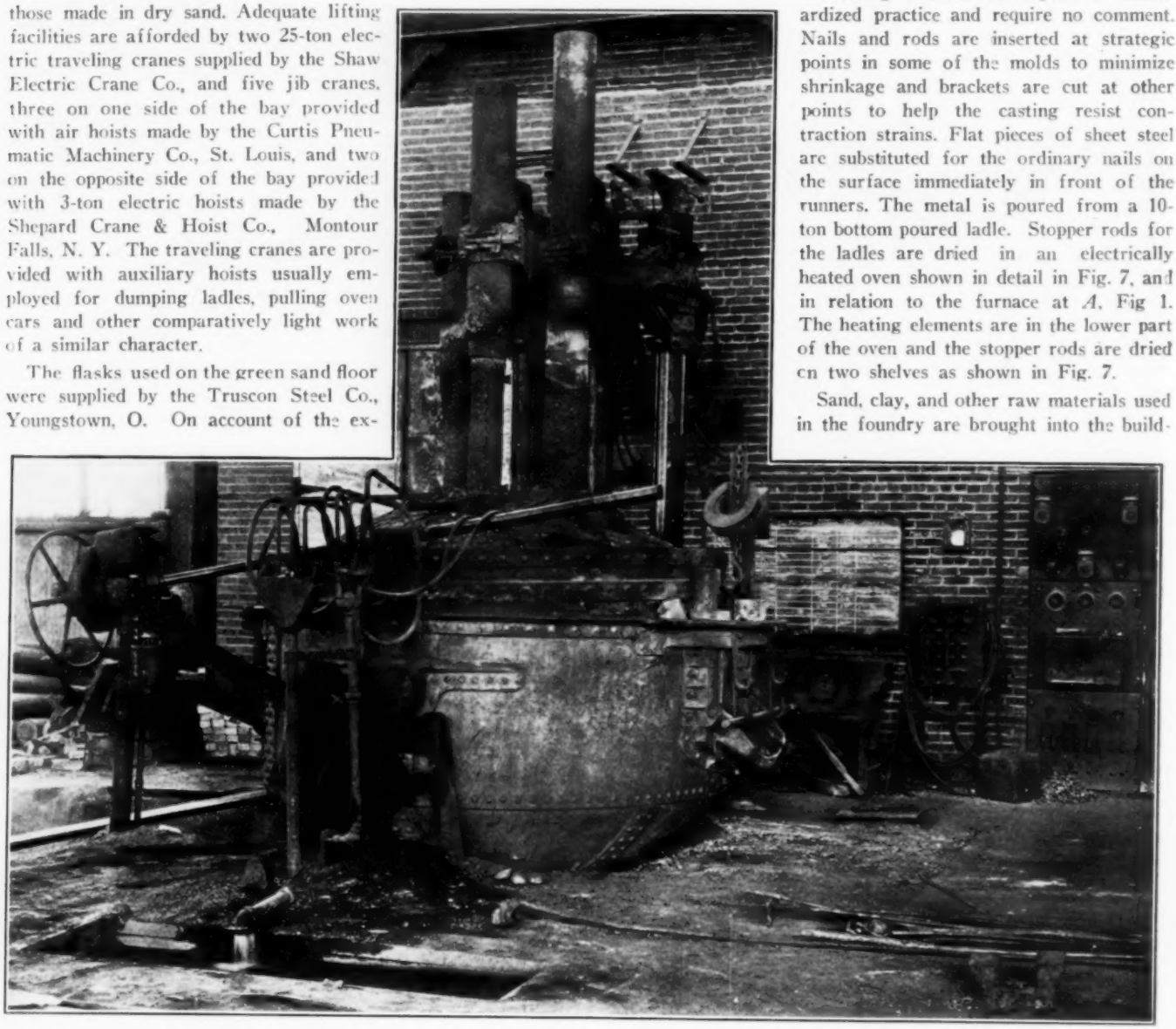

FIG. 6—ON OCCASION THIS FURNACE WITH A RATED CAPACITY OF 3 TONS HAS MELTED 6 TONS AT A HEAT

In addition to the molds that are rammed on the floor, a considerable number are rammed on two large machines made by the Herman Pnuematic Machine Co., Pittsburgh. Smaller molds on the green sand floor are rammed on 12 machines supplied by the International Molding Machine Co., Chicago. One of the large Herman machines on the dry sand floor is served by a sand hopper which is filled from a grab bucket and discharges sand into the flash through a chute controlled by a hand operated gate.

Molding methods correspond to standardized practice and require no comment. Nails and rods are inserted at strategic points in some of the molds to minimize shrinkage and brackets are cut at other points to help the casting resist contraction strains. Flat pieces of sheet steel are substituted for the ordinary nails on the surface immediately in front of the runners. The metal is poured from a 10-ton bottom poured ladle. Stopper rods for the ladles are dried in an electrically heated oven shown in detail in Fig. 7, and in relation to the furnace at *A*, Fig 1. The heating elements are in the lower part of the oven and the stopper rods are dried on two shelves as shown in Fig. 7.

Sand, clay, and other raw materials used in the foundry are brought into the building on a depressed track extending about 100 feet into one end of the center bay. A number of bins are provided on either side of the track in which to unload the material from the railroad cars. Facing and core sand are mixed in the immediate vicinity in two mechanically operated mixers of the pan and roller type; one made by the National Engineering Works, Chicago and the other by the Frost Mfg. Co., Galesburg, Ill. Sand for the small cores is mixed in a mechanically operated riddle made by the Blystone Mfg. Co., Cambridge Springs, Pa.

Cores are dried in a battery of three

ovens made by Holcroft & Co., Detroit and shown in Fig. 8. The cores are loaded on racks and conveyed to and from the ovens by a lift truck. Smaller cores are dried in four supplementary double deck ovens built onto one side of the original battery. The cores are made on the floor or on a number of benches in the ordinary manner. The pouring cup cores are made two at a time in a plain hand jolt roll-over machine shown in Fig 2. One man operates this machine and makes 700 cores per day. He is paid at the rate of 85 cents per hundred cores.

The cleaning bay is spanned by a 10-ton crane made by the Cleveland Crane & Engineering Co., Wickliffe, O., and is connected to the other two bays and also with the yard by two narrow gage tracks extending from one side of the building to the other about midway from each end of the building and at about the same distance from each other.

Railroad cars enter one end of the bay on depressed tracks which bring the doors level with the loading platform. This facilitates loading the smaller castings with trucks or wheelbarrows. Larger castings are loaded by the crane into open cars.

Equipment in the cleaning room includes an oil fired 2-car annealing oven provided with a door at each end; a hydraulic vertical ram for straightening castings; one dust arrester made by Kirk & Blum, Cincinnati; one tumbling barrel supplied by the Whiting Corp., Harvey, Ill.; one sprue cutter made by I. C. Busch, Milwaukee; one sandblast rotary table and car for heavy castings made by the Pangborn Corp., Hagerstown, Md. All the foregoing with the exception of the pump for the hydraulic ram are driven from individual motors. The pump, three swing grinders and two double sand grinders are driven from a single shaft which derives its energy from a 30-horsepower General Electric motor. Oxyacetylene stations for cutting and welding are located at two convenient points.

Old sand from the chipping room is collected once a week, loaded into a car and taken out to the dump. The building is heated by a hot air system installed by Robert Gordon, Inc., Chicago. The company maintains an extensive pattern shop and pattern storage, situated at some distance from the foundry and close to the office building.

FIG. 8—CORES ARE DRIED ON MOVABLE RACKS IN THREE UNDER FIRED OVENS EQUIPPED WITH INDUCED DRAFT APPLIANCES—SMALLER CORES ARE DRIED IN FOUR SUPPLEMENTARY SHELF OVENS ATTACHED TO ONE SIDE OF THE MAIN BATTERY

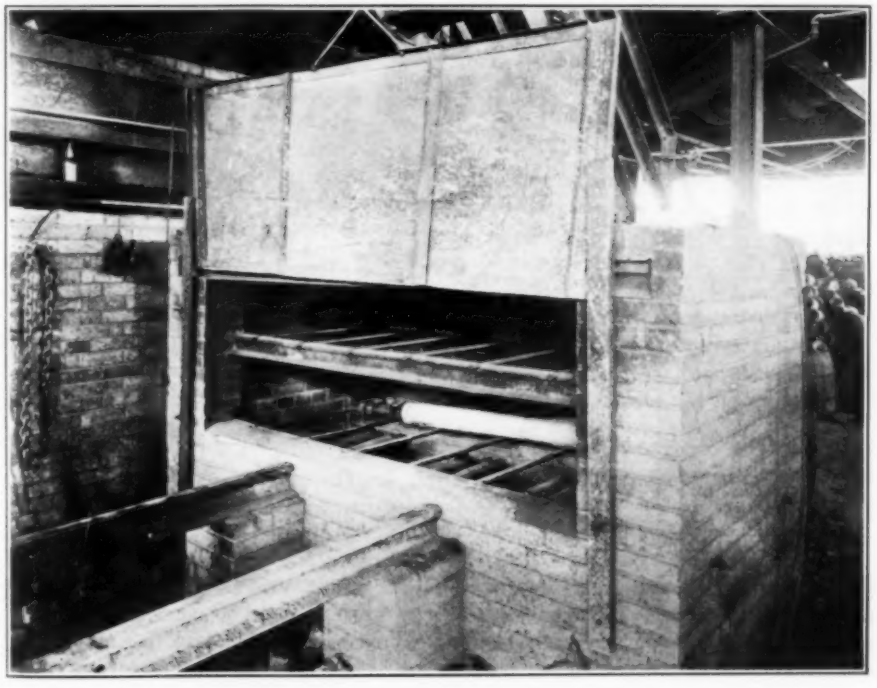

FIG. 7—STOPPER RODS ARE DRIED IN AN ELECTRICALLY HEATED OVEN

Grade Sand-Blast Sand

Although the sizes of sand-blast sand particularly adapted for its various uses has never been determined scientifically a test recently made by a sand producing company showed that a sand capable of passing through a screen with a 0.17-inch mesh but incapable of permeating a screen with a 0.15-inch mesh was excellent for cleaning steel castings. A sand passed through a screen with a 0.15-inch mesh but rejected by a 0.084-inch mesh was found to be particularly suitable for steel and heavy gray-iron castings; while a sand passing through a screen with a 0.084-inch mesh and rejected by a 0.043-inch mesh was used effectively on light gray-iron castings, stove plate and sanitary ware.

Starts Foundry Project

Excavation work has been started on the proposed $150,000 foundry for the Hunt-Spiller Mfg. Corp., at 383 Dorchester avenue, Boston. It will be of brick construction, 50 feet high, approximately 135 x 240 feet, and will contain three units. The Charles R. Gow Co. has the contract for the foundation and the C. A. Dodge Co., Cambridge, Mass., the general contract. Andrews, Rantoul & Jones, Boston, are the engineers in charge of the work. The corporation specializes in iron castings.

W. A. Roedell has established an office at 460 Broadway, Kingston, N. Y., to engage as a consulting specialist in foundry practice.

Test Sand with Doty Machine

Determine Effect of Moisture on Bond of New Sand, Results from Hand Mulling and Machine Mulling, and Effect of Grain Size on the Bond of Sand

BY R. F. HARRINGTON, M. L. MACCOMB and M. A. HOSMER

A GENERAL survey of the work performed in our laboratory in connection with the problem of sand conservation and reclamation, together with the application of the Doty cohesiveness testing machine, discloses many interesting phases of the sand problem. At this time we do not feel that a sufficiently exhaustive study has been made of the various problems to arrive at any positive conclusions. We are confident, however, that the machine when rigidly standardized, so that the results obtained in various laboratories throughout the country may be properly compared, will be a vital factor in the solution of many of the problems encountered in the study of molding sand.

For the interest of the trade and with the desire to stimulate discussion and further investigation we are enumerating the inconsistencies which our investigation has indicated.

For the sake of clarity we have listed the tests in order, stating the object of the test, material used, method of procedure, data secured and results obtained. Results may be either in the nature of positive or negative deductions, or suggestions for further study and investigation.

We have applied it to the study of the various problems as follows:

First—To determine the effect of moisture on the cohesiveness of new sand.

Second—To determine the difference, if any, between new sand, which has been dried out and remoistened, and the same sand with original moisture content.

Third—Effect of 10 minutes hand mulling on the cohesiveness of the new sand.

Fourth—Effect of grain size on the cohesiveness of sand; moisture, bond and other variables remaining constant.

Fifth—To determine the increase in cohesiveness of bushing sand obtained by machine mulling.

Sixth—Extent to which machine mulling brings out the active bonding material as determined by the dye absorption test.

We have found that when using sand of relatively small grain size, and properly mixed to insure uniform distribution of moisture, the results obtained are satisfactory. Not only is the percentage of variation in the weights of different sections of the same bar consistently low, but the weights of the broken sections from different bars, made from the same sand, check closely. Results from tests made on facing sand, enumerated in Table 1, will bear out this statement.

However, when the test is applied to gravel, due to its coarser grain size, poor distribution of moisture, and presence of pellets of clay, a greater percentage of variation in the weight of various sections of the same test bar is obtained, as might be expected. This is illustrated by Table II.

Table I

Tests Made on Facing Sand

Facing Sand Number	Bar Number	Weight of broken sections in grams 1	2	3	4	Average Weight in grams	Percent Maximum Deviation
1	1	191	198	193	191	193	3.6
1	2	193	196	193	189	193	3.7
2	1	190	196	191		192	3.2
2	2	195	197	192		195	2.8
3	1	178	174	179	172	176	4.1
3	2	172	167	179		173	7.2
4	1	212	222	207		213	7.2
4	2	210	217	210		212	3.4

Table II

Tests Made on Gravel

Sample	Test Bar Number	Weight of broken sections in grams gr. 1	2	3	4	Ave. wgt. Gr.	Percent Max. Deviation	Percent Moisture Content
Our Gravel	1	206	211	231	217	219	12.6	5.95
Our Gravel	2	226	232	213	202	218	14.9	5.70
Our Gravel	3	231	203	215	238	222	17.2	5.41
Our Gravel	4	186	187	206	221	200	18.8	4.80
Our Gravel	5	170	180	182	200	188	17.6	7.30

Test No. 1

OBJECT—To determine the effect of moisture on the cohesiveness of our new sand.

MATERIAL USED—New sand.

PROCEDURE—The sample for test was spread out on a concrete floor and allowed to dry. Representative samples of this sand for determination on moisture and cohesiveness were taken at regular intervals. In all, 16 test bars were made and broken results of which are shown in Table III and a curve plotted as shown in Fig. 1, using the average cohesiveness as measured in weight of broken section in grams as ordinates and per cent of moisture content as abscissi.

STUDY OF DATA OF TEST NO. 1

A comparative study of the individual weights of broken sections from the same bar, and of similar bars, made up of the same sand, with small variations in moisture, will serve to show why we hesitate before arriving at any positive conclusion.

After calculating the averages for each test bar and plotting these values against the moisture content as shown in Fig. 1, a study of the curve obtained brings out the following points:

1. Beginning at a maximum of 7.96 per cent moisture and decreasing same by evaporation, we get a corresponding and fairly uniform increase in the cohesiveness of the gravel, until the moisture content has decreased to approximately 6.25 per cent.

2. Varying the moisture content from approximately 6.25 per cent to 5 per cent has but little effect on the cohesiveness of the sand.

3. The cohesiveness decreases rapidly, however, as the moisture falls below 5 per cent.

4. The necessity of obtaining uniform distribution of moisture throughout the heaps before taking sample for Doty test therefore is imperative.

5. The importance of knowing the moisture content of sands when reporting cohesiveness values for means of comparison, cannot be made too emphatic.

6. That great care must be used in ob-

Paper presented at the convention of the American Foundrymen's association, held in Cleveland, April 28 to May 3. The authors are metallurgists, the Hunt Spiller Co., Boston.

taining the moisture contents in heaps.

Test No. 2

OBJECT—To determine to what extent, if any, the drying out of new sand and remoistening of the same increases its cohesiveness as compared with the same sand with original moisture content.

MATERIAL USED—New sand.

PROCEDURE—The sample selected for the test was divided into two portions.

Portion A—Contained the original moisture.

Portion B—Dried out and remoistened.

This test is a continuation of Test No. 1. Several bars from each portion with various percentages of moisture, as indicated in Table IV, were made up and broken in the usual manner. The average value of the weights of broken sections from the individual bars were calculated, and, using the cohesiveness as measured in average weight in grams of broken section as ordinates and percentage of moisture content as abscissi, curves were plotted similar to that of Test No. 1.

Conclusions Drawn from Test No. 2

1. With a moisture content greater than 6 per cent, no appreciable increase in cohesiveness is obtained by drying out and remoistening the sand.

2. With moisture less than 6 per cent an appreciable increase in strength is noted in the sand which is dried out and remoistened. At 5 per cent moisture the increase amounts to 16 per cent.

3. Whereas we find that in the sand with orignal moisture content, when this moisture varies between 5 and 6.25 per cent, there is little variation in breaking load, we note that in the sand which has been dried and remoistened, there is a progressive increase until a maximum of 5.4 per cent moisture is reached. Above this point a corresponding progressive decrease is noticed until a moisture of 4.5 per cent is obtained. The strength of the latter at 4.7 per cent moisture compares favorably with that of the original sand at 5.1 per cent.

4. Does the increase in strength depend entirely upon the drying out effect or is it caused by the work expended upon it in the form of hand mulling, which is necessary to distribute the moisture uniformly throughout the sand?

Table III

Results of Cohesiveness Tests

Sample	Bar Number	Weight of Broken Sections in Grams 1	2	3	4	5	6	Average Weight in Grams	Per cent Moisture
New Sand	1	158	156	176	166	166	161	164	7.96
New Sand	2	168	172	175	168	186		174	7.60
New Sand	3	165	177	192	183	179		179	7.32
New Sand	4	170	180	182	200			188	7.30
New Sand	5	178	178	211	185	202		191	6.69
New Sand	6	178	208	196	203	196		196	6.66
New Sand	7	215	220	212	242			222	6.25
New Sand	8	206	211	231	217			219	5.95
New Sand	9	190	205	229	267			223	5.90
New Sand	11	231	203	215	238			222	5.41
New Sand	10	226	232	213	202			218	5.70
New Sand	12	211	222	222				218	5.20
New Sand	13	211	217	231	236			223	5.12
New Sand	14	187	186	207	221			200	4.80
New Sand	15	192	176	186	182			184	4.62
New Sand	16	175	176	140	169	149		162	4.47

Test No. 3

OBJECT—A study of the curves in Test No. 2 showing the difference in cohesiveness of the sand which has been dried and remoistened as compared with the cohesiveness of the same sand with original moisture content, clearly indicates that the sand which has been dried and remoistened is appreciably stronger, when the moisture content is below 6 per cent. Are we justified in assuming that this increase in cohesiveness is attributed to the drying out of the sand, or are there other factors to be considered?

After the moisture was added to the air dried sand, work in the form of hand mulling was necessary to distribute the moisture throughout the sample. Since it is generally known that mulling increases the strength of molding sand, is it not possible that the increase in cohesiveness was due to the hand mulling which the sand received, as noted? With the latter thought in mind work was undertaken to determine this fact.

MATERIAL USED—Millville gravel.

PROCEDURE—The sample for investigation was dried and divided into three parts.

Part *A*—With original moisture content and not worked. Four bars were made up and broken in the usual manner.

Part *B*—Similar to *A* except that the sand was worked by hand for a period of 10 minutes, after which four test bars were broken.

Part *C*—Differed from *B* in that this sand was thoroughly dried, remoistened to the same moisture as that of *B*, and worked by hand for 10 minutes. Test bars were then broken.

All results were tabulated and averages calculated. A comparative study was made as shown in Table V.

Results of Test No. 3 Analyzed

It may be noted that sand *B* with an average weight of broken sections of 147.45 grams is 6 per cent stronger than sand *A*, which has an average weight of 139 grams. Also sand *C*, with an average of 152 grams, is 9 per cent stronger than sand *A*. Now knowing that hand mulling in Millville gravel containing 9 per cent moisture increases its cohesiveness 6 per cent and also that Millville gravel dried and remoistened to 5 per cent has a cohesiveness of 16 per cent greater than the same gravel containing 5 per cent original moisture, we ask if this increase in strength can be credited to the mulling action which the sand receives when the moisture is worked into the sand?

Returning again to the curve in Test No. 2, and bearing in mind that only enough work in the form of hand mulling has been done on the sand which is dried and remoistened, to mix the moisture uniformly throughout the sample, we find that with a moisture content

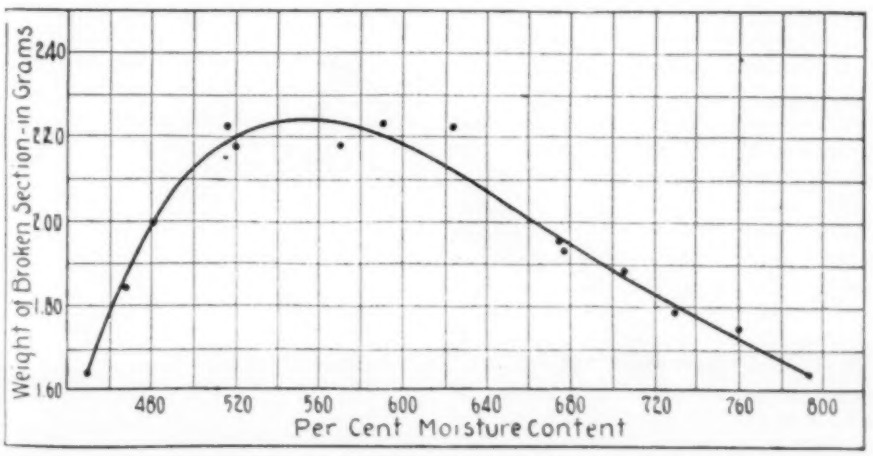

FIG. 1—EFFECT OF MOISTURE ON BOND OF NEW SAND

greater than 6 per cent the curves nearly coincide.

With this data at hand and recognizing that the work done on the sand during the hand mixing does increase its cohesiveness when the moisture content is 9 per cent, we do not feel that this increase of 16 per cent in the dried and remoistened sand, over the sand with the original moisture, can be attributed entirely to the mulling action. What factor then is responsible for this increase in cohesiveness?

A rational physical analysis of Millville gravel shows that it is composed of the following:

Silica grains of various sizes.
Course grains of feldspar.
Clay substance.
Transitional feldspar.
Black particles which are probably hornblende.

Close examination reveals the presence of numerous pellets of clay. If we believe that this increase in cohesiveness in the sand which has been dried in this case, in spite of the fact that the sand appears fairly moist to the feel of the hand.

Now up to this point of 6 per cent moisture, the sand was dependent for its cohesiveness solely on clay substance which becomes stronger in plasticity simultaneously with increase in moisture absorbed. Beyond 6 per cent the excess water which will not be taken up by the clay substance, coats the grains of silica and feldspar and we now have not only plastic clay substance but in adition, water, to bind these grains of silica and feldspar together.

Since water is not as strong a binder as clay substance, the greater the percentage of the binder that is water, the less the cohesiveness of the sand. Consequently the excess moisture which therefore weakens the mixture, takes away from the sand that property of added cohesiveness obtained in sands of lower moisture content by mulling.

When the moisture in the original sand is allowed to evaporate, the loss of

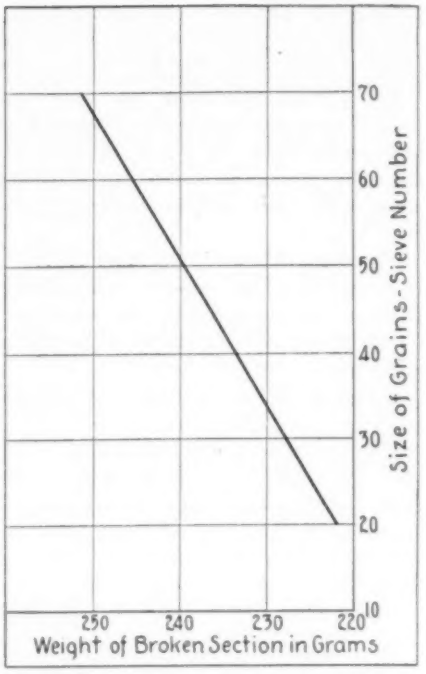

FIG. 3—EFFECT OF GRAIN SIZE ON THE COHESIVENESS OF SAND

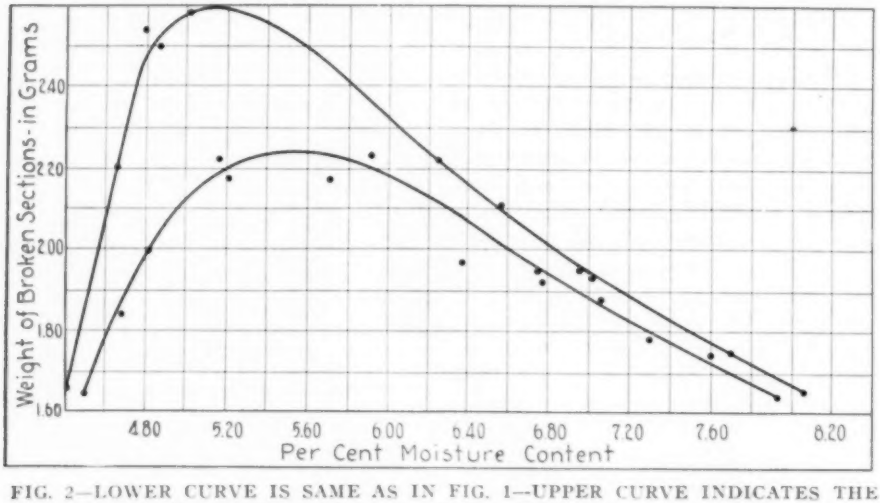

FIG. 2—LOWER CURVE IS SAME AS IN FIG. 1—UPPER CURVE INDICATES THE INCREASED BOND STRENGTH WHEN THE SAND IS DRIED AND REMOISTENED TO ORIGINAL WATER CONTENT

is due to the decomposition of the clay pellets and resulting better distribution of the clay particles around the silica and grains of feldspar, why is there not a corresponding increase when the moisture content is greater than 6 per cent?

To show why this is true, we offer the following explanation. It is quite apparent that the clay substance in sand takes up water thereby developing its plasticity with the addition of moisture, until this plasticity has reached a maximum. This maximum is attained at the same time that the clay substances ceases absorbing water, and until this point is reached, all the moisture then present in the sand is found in the clay substance.

This theory is substantiated by carefully examining a sample of sand containing a moisture of less than 6 per cent. The particles of silica and feldspar are found to be entirely free from moisture moisture takes place simultaneously from the clay, silica and feldspar grains, so that there is no time when the moisture present is contained by the clay particles alone.

To illustrate, let us take two sands of equal moisture content; sand *A*, which has been allowed to dry from 9 per cent moisture, and sand *B*, which has been wet from the dry state. Assuming this moisture content to be 5 per cent in both sands, according to our previous theory sand *A* would have part of its moisture present in the clay substance and part covering the grains of silica and feldspar. Sand *B*, on the other hand, would have the entire amount of its water in the clay substance. Now since the moisture content of the clay substance in sand *B* therefore, must be more than that in sand *A* the latter must be the weaker sand. This we have previously shown in Fig. 2 no doubt would be the case.

Test No. 4

OBJECT—To determine the effect of grain size on the cohesivenes of sand. Moisture, bond and weight of sample taken were constant in each case.

MATERIAL USED—The test sand was made up of equal parts of the following:

Fine beach sand.
Coarse beach sand.
Wareham core sand.
Furnace bottom sand.

After a thorough mixing this sand was dried under the hot plate, screened and classified as follows:

Sand *A*—Portion which remained on

Table IV

Test No. 2

Per cent Moisture	Ave. of Broken Sects. in Grams. Sand Dried	Sand Dried And Remoistened
8.02		
8.02		163
7.96	164	
7.74		174
7.60	174	
7.32	179	
6.94		192
6.92		194
6.69	191	
6.66	196	
6.37		197
6.25	222	
6.13		227
5.95	219	
5.92		236
5.90	223	
5.70	218	
5.41	222	
5.20	218	
5.12	223	
5.00		257
4.84		250
4.80	200	
4.72		254
4.67		220
4.62	187	
4.47	162	
4.30		212

Table V

Tests Made on Millville Gravel

Kind of Sand	Weight of Broken Section in Grams	Average Weight in Grams	General Average Weight in Grams	Average Moisture Per Cent
A	130 131 128 147 149	137		
A	128 137 140 140	136		
A	141 148 145 138 153	145	139	9
A	133 137 141 143	139		
B	152 142 145 154 147	148		
B	144 148 153	148		
B	136 156 142 157 143	147	147.5	9
B	146 143 140 152 153	147		
C	155 150 152 154 157	153		
C	145 152 155 153	151	152	9
C	157 151 147 152	152		

the No. 6 screen. There was not enough of this sand to run a test.

Sand *B*—Portion which passed through No. 6 sieve and remained on No. 12. Not enough of this sample to make a test.

Sand *C*—Portion which was retained by the No. 20 sieve.

Sand *D*—Portion which remained on No. 40 sieve.

Sand *E*—Portion which remained on No. 70 sieve.

Sand *F*—All grains which passed through No. 70 sieve.

PROCEDURE—Test bars were made, keeping the amount of clay, water and sand constant. The mixtures were mulled by hand to insure uniform mixing of the sand, clay and water, and bars made up and broken in the usual manner. The results are shown in Tables VI.

The individual results obtained are shown in Table VII. A curve plotted in Fig. 3, with *breaking strength in grams* as ordinates and *grain size* as abscissi.

The results clearly indicate that the effect of grain size in the cohesiveness of molding sands is a vital factor. At this writing we do not feel that a sufficient number of tests have been made in this problem to warrant the establishment of any rigid relationship between the grain size and the cohesiveness. However, we are confident that we have found a valuable application for the Doty testing machine and hope that time may be available in the future to establish this relationship.

The fact that the test sand was made up of a mixture of four different kinds of sand is one unfavorable feature of the test. We believe that better results, or at least results of greater value, would have been obtained if only one kind of sand had been selected for the original sample.

Test No. 5

OBJECT—To determine to what extent machine mulling increases the cohesiveness of our bushing sand as compared with the same sand mixed by hand.

To determine to what extent, if any, drying, remoistening and machine mulling increases its strength.

MATERIAL USED—A mixture containing 32 parts of old bushing sand and 10 parts of new sand.

METHOD OF PROCEDURE—Sample was well mixed by hand and divided into three portions. From each, samples were taken for moisture and Doty test.

Portion *A* is hand mixed.

Portion *B* machine mulled for two minutes.

Portion *C* allowed to dry in the open, remoistened and machine mulled for two minutes.

The results of Test No. 5 are shown in Table VIII. Studying the data in this table we find that:

The average moisture content of sand *A* is 8.14 per cent, whereas sand *B*, which is the same in all respects excepting that it has been mulled for 2 minutes, gives a moisture of 7.96 per cent, or a decrease of 0.18 per cent. Since *A* was hand mixed it was very difficult to secure a uniform distribution of the moisture, this fact is borne out by the results of the moisture determinations, the figures for which are given below:

Sample Number	Percentage Moisture	Average
1	7.59	...
2	8.00	8.14
3	8.82	...

An increase of 36.7 per cent in cohesiveness of sand *B* over sand *A*.

An increase of 48.6 per cent in cohesiveness of sand *C* over sand *A*.

Ignoring the fact that the moisture in sand *C* is less than in sand *B*, can we assume that by drying the sand and remoistening it we increase its strength by an amount equal to the difference between 48.6 per cent and 36.7 per cent or 11.9 per cent. Let us return to the curve, Fig. 2, in Test No. 3 showing the effect of moisture content on the strength of new sand and assuming that the effects of moisture in both our new sand and bushing sand are comparable, we find that with new sand, with a moisture content of 7.96 per cent can have a cohesiveness of 165 grams, and with moisture of 7.2 per cent a cohesiveness of 185 grams, a difference of 7.96 less 7.12 or 0.84 per cent in moisture between sand *B* and sand *C*, gives an increase in cohesiveness of regular sand equal to 11.9 per cent; while the same decrease in moisture in new sand produces a corresponding increase in strength of 12.1 per cent. Then the increase in strength of sand *C* over sand *B* is not due to the drying effect but to the difference in moisture content.

Conclusions Drawn from Test No. 5

1. Two minutes of machine mulling increases the strength of our bushing sand by approximately 36 per cent.

2. With sand with nearly 8 per cent moisture no apparent increase in cohesiveness is obtained by drying and remoistening.

3. An increase of cohesiveness in the same sand with the same mulling can be obtained by decreasing the moisture.

Test No. 6

OBJECT—To determine if by machine mulling our bushing sand we are able to increase the effectiveness of the clay substance present as measured by the dye adsorption test.

MATERIAL USED—Regular bushing sand containing 10 parts of our new sand and 32 parts of old bushing sand.

PROCEDURE—The above was mixed by hand and a portion, *A*, was taken for bond determination. A second portion, *B*, was machine mulled for 25 minutes and sampled for bond determination.

Results of Test No. 6

Sample	Bond	Average Bond
Portion A	448	416

Table VI

Effect of Grain Size

Sample Number	Amount of Sand	Clay in Grams	C.C. Water	Average Weight of Broken Section in Grams
1	900 of C	350	70	222
2	900 of D	350	70	233
3	900 of E	350	70	255
4	900 of F	350	70	282

Table VII

Effect of Grain Size

Bar No.	Grade of Sand	Weight of Broken Section in Grams Section 1	Section 2	Section 3	Average Weight
1	C	222	222	221	222
2	D	231	235		234
3	E	251	258	255	255
4	F	282	282		282

Portion A	384	...
Portion B	512	504
Portion B	496	...

We regret that time was not permitted for a more extensive investigation of this phenomenon. The little work done clearly indicates that machine mulling does increase the bonding strength of the clay substance present. In this test the increase amounted to 22 per cent.

As we stated in the introduction of this brief outline, we do not feel that a sufficiently exhaustive study of the various problems has been made at this writing to arrive at any positive conclusion, nevertheless, a careful examination of the foregoing seems to bring out certain relations which may or may not hold true at all times, but which are, nevertheless, of interest, and may serve to stimulate further study in this direction.

The salient points, therefore, are enumerated in the following general summary:

The Doty method of cohesiveness testing when properly standardized is an excellent method of comparative work.

Moisture plays a vital part in comparing the strength of sand, and never should be omitted when reporting comparative tests by the Doty machine.

With a moisture content of less than 6 per cent, an appreciable difference in the strength of two sands is noticed when one is dried and remoistened to the original percentage, while the other retains its original moisture.

Drying and remoistening increases the cohesiveness of sand when the moisture content is below 6 per cent, but above 6 per cent moisture, its added strength is offset more or less by the weakness of excess moisture present.

All other factors being constant, the cohesiveness of molding sand varies as the grain size.

Machine mulling brings out to a more or less extent the active bonding material as determined by the dye adsorption test.

Table VIII

Effect of Machine Mulling

Kind of Sand	Weight of Broken Section in Grams 1	2	3	4	5	6	Average Weight in Grams	General Average in Grams	Average Moisture Content, per cent
A	90	111	102	101	104		102		
A	90	117	111	123	118		112	108	8.14
A	86	103	115	112	131	113	110		
B	135	146	141	147			142		
B	140	141	138	148	149		143		
B	144	151	146	143	151		147	144	7.96
B	140	146	140	151			144		
C	160	154	166	174			164		
C	163	166	162				164		
C	156	160	155	151			156	162	7.62
C	175	155	157				162		

Committee Studies Pipe Specifications

The American Gas association has submitted for the approval of the American Engineering Standards committee three specifications for cast iron pipe and special castings. These specifications were developed in 1911 by the American Gas institute, at which time the dimensions for the bell and spigot castings were adopted. In 1913 the association adopted the dimensions for flanged castings, and specifications governing the manufacture of all cast iron pipe and specials, which were derived from an old standard adopted in 1905 by the American Gas Light association. The specifications now under consideration are said to be in general use for underground pipes throughout the United States.

The American Engineering Standards committee has appointed a large and representative committee to consider the application for the approval of these specifications, they also will sponsor future revisions and consider and develop necessary changes. The following are members of the special committee: S. G. Flagg Jr., chairman American Society of Mechanical Engineers; F. A. Barbour, American Water Works association; E. A. Barrier, fire protection group; W. Forestall, American Gas association; A. H. Hall, American Gas association; W. G. Hammerstrom, Lynchburg Foundry Co., Lynchburg, Va.; H. Kely, Associated General Contractors of America; N. F. S. Russell, U. S. Cast Iron Pipe & Foundry Co.; R. Toensfelt, American Society for Municipal Improvements; W. Wood, Wood & Co.; C. D. Young, American Society for Testing Materials; F. A. McInnes, New England Water Works association; F. F. Schauser, Natural Gas Association of America; A. W. Claussen, Underwriter's Laboratories; and J. C. Meloon National Automatic Sprinkler association.

Suggestions for Foundry Practice Offered

The Hillside Fluor Spar Mines, Chicago, has published a complimentary pamphlet in which suggestions regarding the customary practice in foundries are given. The information is collected from authoritative sources, and deals principally with the operation and care of a cupola, concluding with a discussion of various fluxes.

The value of fluorspar is outlined together with an exposition of its sources, characteristics, and uses. The manufacturers claim that the benefits derived from its use as a flux include a reduction of coke, greater freedom of the castings and metal from slag, and a diminution of the slag accumulation in the cupola.

According to the manufacturers the value of fluorspar as a flux is comparatively unappreciated and they define it as a non-metallic mineral of moderate cost of commercial value only, but essential and of economic importance to the iron industry from the fact that 80 per cent of the world's production of fluorspar is used in open-hearth, electric furnaces and iron foundries.

Additional information is given in the pamphlet concerning the use of other fluxes as well as quotations from authorities regarding their use. A table also is given showing the chemical analyses for different classes of castings which the Hillside company recommend as being dependable.

Book Review

Analysis of Steel, by Frank T. Sisco, 543 pages, 6 x 9; published by McGraw-Hill Book Co., Inc., New York and supplied by THE FOUNDRY, Cleveland, price $5.00.

While this volume treats primarily of laboratory methods, processes, and chemical analysis, it will constitute a useful book for all foundries maintaining their own laboratories. Several chapters are devoted to the analysis of pig iron, cast iron, and allied materials. The analysis of fluxes and refractories is also the subject of a chapter. Carbon and its determination in plain and alloy steels is discussed at considerable length. The composition of all the compounds of steel is ably reviewed by the author who has had much experience in this field. However, the chief value of the book lies in its vast amount of information on the analytical tests for steel and its alloys as well as the tests for all the materials pertaining to its preparation.

Walter B. Enck, formerly operating as Walter B. Enck, Inc., with offices in the Pennsylvania building, Philadelphia, has been appointed resident manager at the same address, for the Pioneer Coal & Coke Co., Oliver building, Pittsburgh. He will handle the latter interest's sales in the territory in connection with Pittsburgh, Westmoreland, Youghiogheny steam, gas and by-product coal as well as standard furnace and foundry cokes.

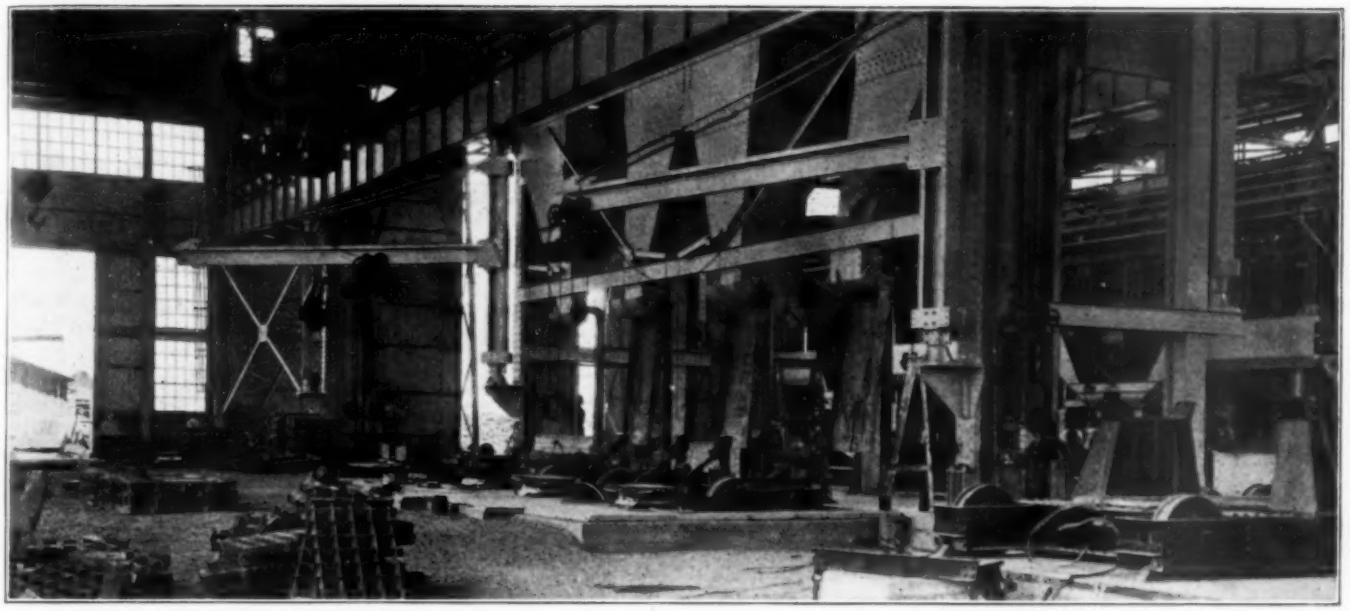

Fig. 1—One of the Casting Departments of New Steel Foundry Showing Jolt Rollover Machines and Chutes From Elevated Sand Bins

Features Foundry Equipment

New Steel Plant of Tennessee Coal, Iron & Railroad Co. Has Been Equipped with Handling and Production Machinery of the Latest Design—Large Capacity Provided

BY E. C. KREUTZBERG

A NEW steel foundry embodying substantially all of the most modern developments in casting practice recently was completed by the Tennessee Coal, Iron & Railroad Co. at its Fairfield car works, Fairfield, Ala. The first heat was poured April 14. The new plant represents a concentration and replacement, as well as an expansion in capacity, of two previously existing steel foundries, one at the Ensley steel works and the other at the shops of the Birmingham Southern railroad, a subsidiary of the Tennessee company. It was designed for the manufacture of miscellaneous car castings on a production basis, and of miscellaneous steel castings required for the various plants of the company in the Birmingham district. Making ample allowances for scrap losses, the new foundry is rated as having capacity for producing about 1400 tons of steel castings per month.

Layout Carefully Arranged

Careful thought was given to every detail of the construction, layout and equipment so as to insure the most favorable operating conditions and the most efficient production possible. In fact, labor-saving methods are employed and materials are handled automatically to an unusual extent in the new foundry.

The building is of steel construction and has shale brick exterior walls with concrete copings which extend five feet above the general yard level. Above the walls are large areas of glass. The foundry space is divided into a main bay and two leantos as shown in Fig. 2. The main bay is 80 x 400 feet, the east leanto 50 x 400 feet and the west leanto 50 x 450 feet. Thus the three bays have a combined floor space of 74,500 square feet. The roof of the main bay is of corrugated asbestos protected metal and the roofs over the two leantos of cast-in-place gypsum slabs covered with composition roofing. Ventilation is afforded by eight ventilators each 8 feet in diameter, built by the Swartout Co., Cleveland. Unusually liberal allowances have been made in the design of this building for height. In the main bay the crane runway is 45 feet high, with the bottom chord of the roof trusses 65 feet above the floor level. In each of the leanto bays the crane runway is 31 feet and the bottom chord of roof trusses 41 feet, 8 inches above floor level.

As far as possible the foundry floor space is conserved for the necessary molding and casting operations. To this end, the flask storage is located outside of the building north of the main bay. The main bay crane runway extends 100 feet outside of the building over the flask storage and the flasks are transferred in and out of the foundry as needed by means of the foundry cranes. Only the flasks actually in service are kept inside of the building.

Flasks Are Stored Outside

Pig iron, scrap and some other materials are stored in an 83 x 200-foot space east of the flask storage yard. This stockyard is served by an electric overhead traveling crane mounted on a runway having a crane rail elevation of 45 feet above the ground level. The pig iron and scrap are received in standard gage gondola cars which are unloaded by means of magnets. The magnets also are used for handling the charges for the open-hearth furnaces. The charging boxes are placed on cradles on the stockyard floor and after being filled, are elevated by the crane to

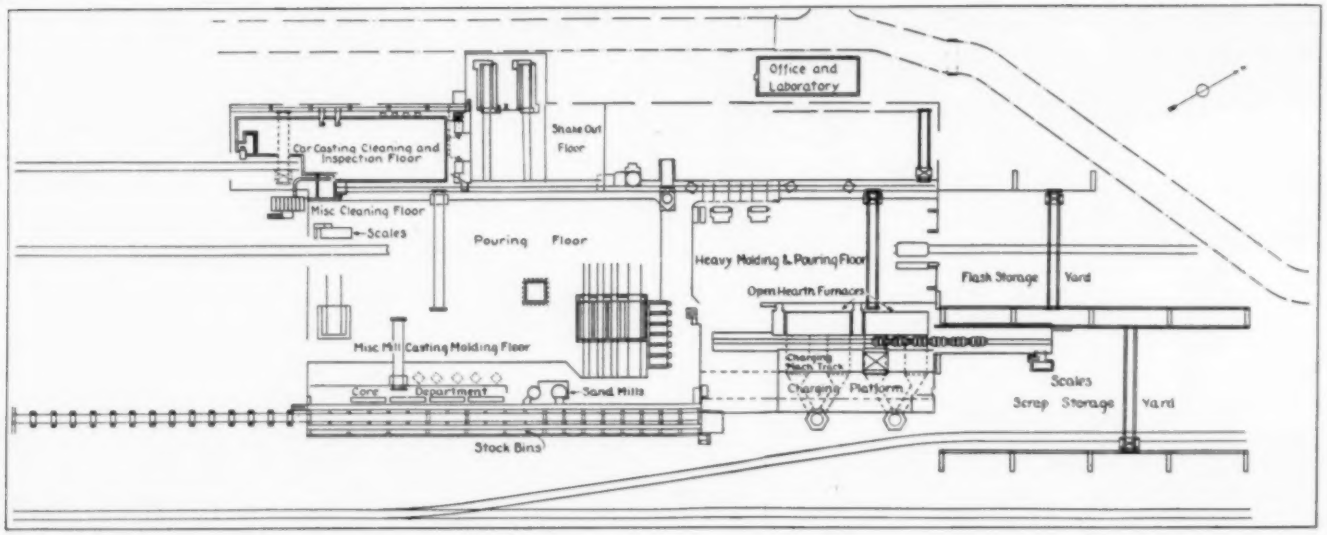

FIG. 2—PLAN OF NEW STEEL FOUNDRY AT THE FAIRFIELD CAR WORKS OF THE TENNESSEE COAL, IRON & RAILROAD CO.

an extension of the charging floor where they are placed on the charging cars, three boxes to a car.

Sand, coke, clay, limestone, etc., are stored in concrete bins located alongside the east leanto, but which are enclosed and form a part of the building. A material track having an inclined approach enters from the south end and passes over the storage bins at an elevation of approximately 12 feet above the floor level. The materials are received in drop bottom hopper cars so that they may be dropped directly into their respective bins. All of these bins are commanded by an overhead monorail telpher system for delivering the materials to the sand mills and charging floor.

Seven Cranes Serve Foundry

Excellent crane service is provided throughout the foundry. Three cranes with auxiliary hoists command the main bay, one 75 and two 25-ton. The largest crane is used exclusively for handling hot metal. Three cranes serve the west leanto, two 20-ton and one 10-ton. The two 20-ton cranes are used for handling hot metal ladles and moving molds in multiples and the 10-ton crane is used exclusively in the cleaning and shipping department. The east leanto is provided with one 10-ton crane for general service.

Two 25-ton basic open-hearth furnaces of the stationary type comprise the melting equipment. These are in the north portion of the east leanto and are elevated sufficiently to accommodate the charging floor, which

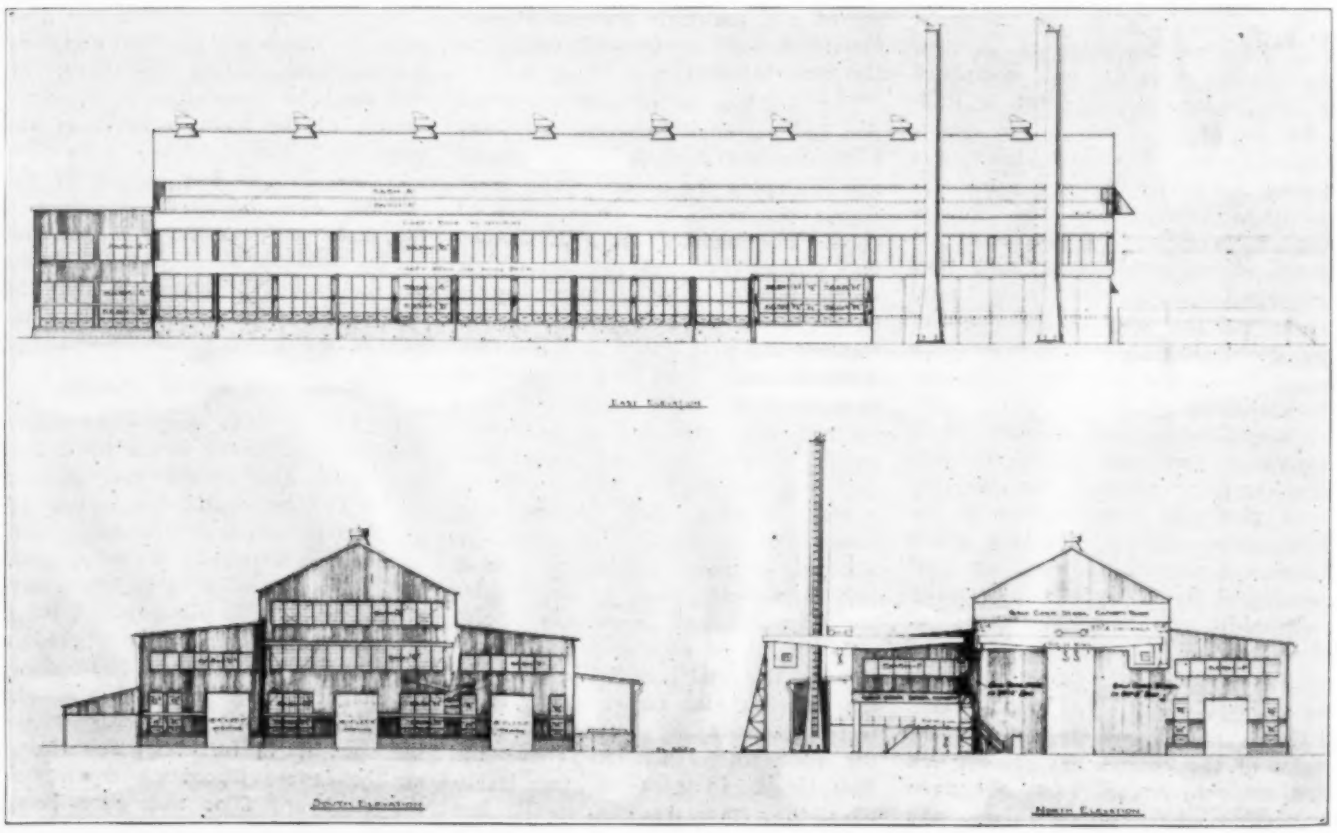

FIG. 3—EAST, SOUTH AND NORTH ELEVATIONS OF NEW STEEL FOUNDRY BUILDING

is 12 feet above the floor level. The pouring sides of the furnaces extend slightly into the main bay of the foundry permitting the hot metal to flow into ladles suspended by cranes in the main bay. The furnaces are designed for the use of tar and by-product gas as fuel and are therefore provided with air regenerating chambers only. The simple arrangement of the stack dampers and air valves and also the direct course of the flues to the stack are important features in the design of these furnaces. The air valves, dampers, and furnace doors are all electrically operated from central stations on the charging floor directly opposite each of the furnaces. Space has been provided for the installation of a third open-hearth furnace when needed. To manipulate the charging cars and charge the furnaces, a 3-ton, high type charging machine built by the Wellman-Seaver-Morgan Co., Cleveland, has been installed.

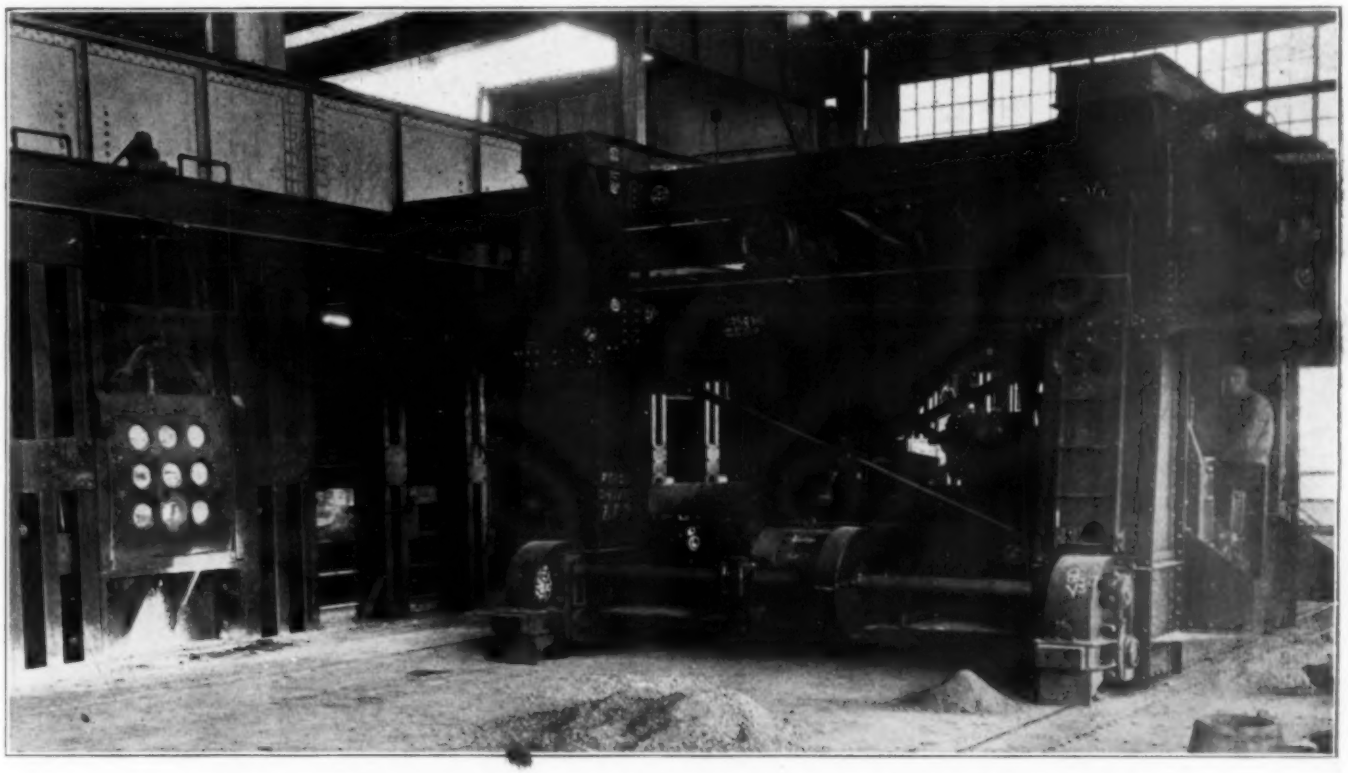

FIG. 4—OPEN-HEARTH FURNACES FROM CHARGING SIDE SHOWING THE CHARGING MACHINE

The west bay of the foundry is intended exclusively for the manufacture of miscellaneous car castings and other small castings. Here are made all the castings which the company requires for its car department with the exception of the side frames and bolsters, chilled iron car wheels and malleable castings. These castings are obtained elsewhere. Only machine molding is done in this bay, the equipment comprising five jar, roll-over and stripper machines built by the Herman Pneumatic Machine Co., Pittsburgh. Four of these machines have been placed in one group for production work, so that the cope and drag of each mold are made simultaneously on each pair of machines. The fifth machine is separated from the others and is used for special molding. The iron flasks are placed on these machines by means of jib cranes with electric hoists. The completed molds are transferred from the molding machines by the same jib cranes and placed alongside of the machines on skids, each skid accommodating four completed molds. The skids then are transferred by an overhead traveling crane and placed in position on the pouring floor. Hot metal required for this section of the foundry is supplied by transferring the ladles on a transfer car from the main bay into this leanto.

Sand Handling System Efficient

An efficient sand handling system has been installed in this foundry. Directly over the group of jar and rollover molding machines are elevated sand bins of steel construction from which sand is delivered directly into the flasks placed on the jar machines. The sand is prepared in an 8-foot mixer manufactured by the National Engineering Co., Chicago, from which it is discharged into an elevator. The latter delivers on a belt conveyor which discharges the sand into the elevated bins. An individual scraper at each bin, operated from the mixing platform, is used to deflect the sand into the bins as required.

After being poured, the molds, still on the skids, are transferred to the shake-out floor. A Herman-type plain jarring machine, elevated on a high foundation, is used for shaking out the flasks. The castings, after being flogged, are placed on grids and then charged into the annealing furnaces. These are of the car type and two in number, each 7 feet, 4 inches x 28 feet, 6 inches. The fuel used in them is high pressure by-product gas. After being annealed, the castings are cleaned in two 48-inch diameter exhaust tumbling mills. After tumbling, the castings are further cleaned by means of flexible shaft and stationary grinders. All gate cutting and welding and welding of castings are accomplished by the oxyacetylene method. They are then removed to the shipping department, which is located at the extreme south end of the west bay. In the annealing and shipping departments wood block floor construction is used. Shipping tracks in this bay extend approximately 50 feet into the building. Large scales are provided adjacent to each track in order that all castings may be weighed prior to shipping.

The main foundry bay is used for molding, pouring and cleaning large

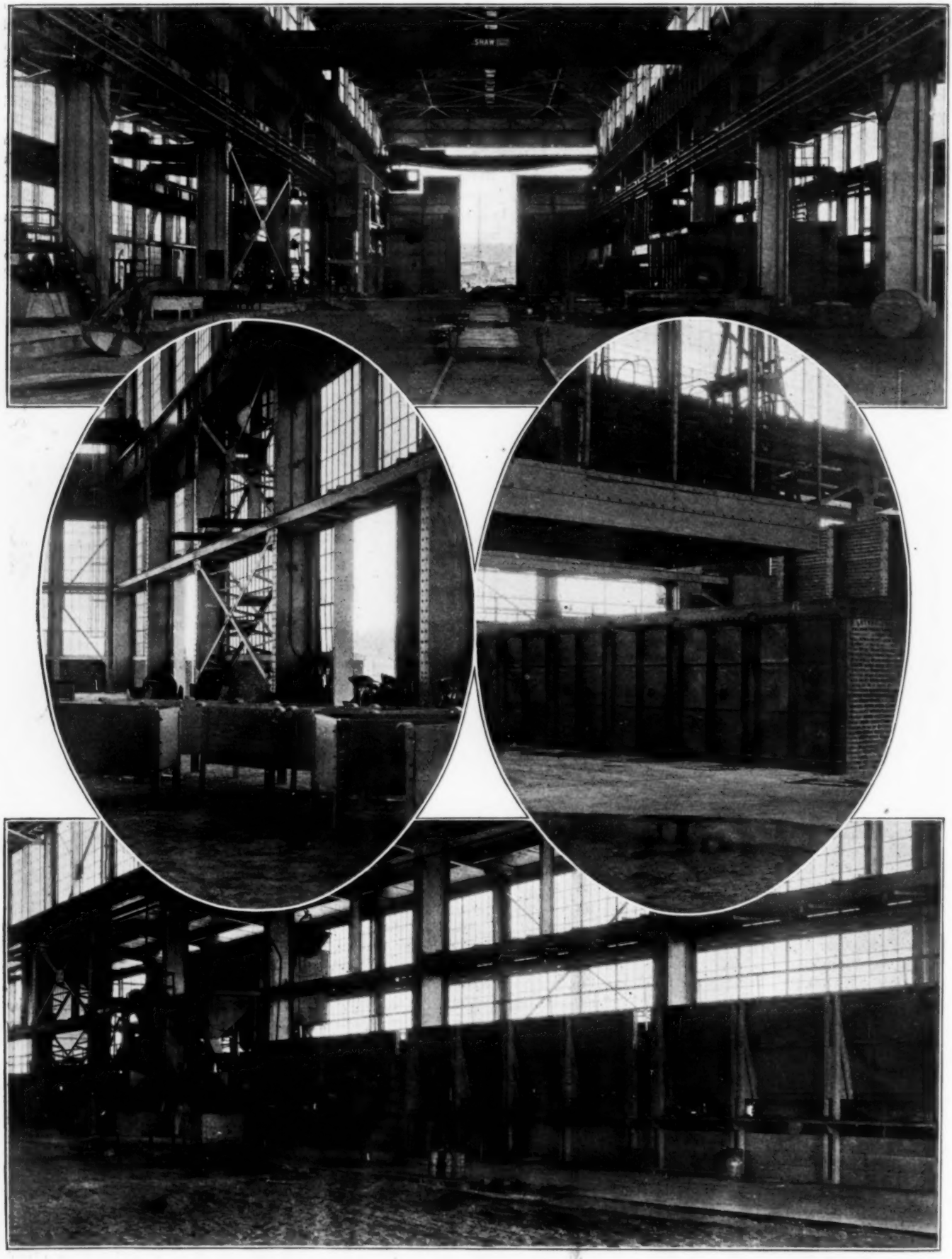

FIG. 5—VIEW OF MAIN BAY SHOWING MOLDING FLOOR AND OPEN-HEARTH FURNACES FIG. 6—CLEANING FLOOR FIG. 7—CORE OVENS AND (ABOVE) TRANSFORMER STATION FIG. 8—A VIEW IN CORE DEPARTMENT—STOCK BINS ARE CONVENIENTLY LOCATED BEHIND THE BENCHES

and miscellaneous castings for the various plants of the Tennessee Coal, Iron & Railroad Co. The equipment consists of four gas-fired, mold-drying ovens, one car type, 16 x 17-foot, annealing furnace and one 12 x 16-foot, sand blast room. Two large Herman-type jar, rollover and stripper machines have been provided. The sand bins for these machines are combined in the same unit with the sand bins used for the west leanto and they are fed by the same equipment.

All of the east leanto, with the exception of that portion occupied by the open-hearth furnaces and charging floor, is used for sand mixing and core making. Two sand mills are located in this department. One is a small 6-foot Simpson-type mill for mixing core sand and the other is a large 9-foot mill built by the Frost Mfg. Co., Galesburg, Ill., for mixing foundry sand. For making cores, a long continuous bench has been provided, with overhead sand bins of wood construction. The sand is transferred from the core sand mixing mill to these bins by means of dumping buckets carried by a 2-ton monorail trolley. For drying the cores six 6 x 12 foot-gas-fired ovens have been installed. The cores, on portable racks, are transferred from the core making department to the core ovens by automatic storage battery lift trucks. After baking, the cores are transferred in the same manner for use in the various parts of the foundry. These lift trucks, which are regarded at the plant as ideal for this work, were made by the Automatic Transportation Co., Buffalo. They travel on concrete runways which were specially provided for this purpose. The mixed foundry sand from the large Frost-type mill is also conveyed in boxes to various points in the foundry by means of the lift trucks, in conjunction with overhead traveling cranes.

One of the features of the foundry is the extensive employment of heat measuring instruments, thus eliminating guesswork and enabling the company to obtain definite results in the annealing and drying operations. The annealing furnaces are equipped with recording potentiometers manufactured by the Leeds-Northrup Co., Philadelphia, having a range from 200 to 1800 degrees Fahr. Recording instruments are located in the laboratory where the foundry superintendent is furnished with complete and continuous records. The mold drying and core ovens are equipped with recording thermometers made by the Bristol Co., Waterbury, Conn.

Another interesting feature of the foundry is that by-product gas, under high pressure, is used as the fuel for annealing and for drying cores and molds. This system was installed by the surface Combustion Engineering Co. The gas is delivered to the plant at a pressure of from 10 to 20 ounces and is then compressed and delivered to the furnaces at from 10 to 15 pounds pressure. This system has been found economical and entirely satisfactory at this plant.

A completely equipped chemical laboratory for the use of the foundry department is housed in part of a brick building west of the foundry. The remainder of this building is used as offices for the foundry superintendents and clerks.

FIG. 9—ANNEALING OVENS AND TUMBLING MILLS IN THE LIGHT CASTING DEPARTMENT

Book Review

The Electric Furnace for Iron and Steel, by Alfred Stansfield, cloth 453 pages, 6 x 9; published by McGraw-Hill Book Co., Inc., New York and supplied by THE FOUNDRY, Cleveland, price $5.00 net.

The history and development of the electric furnace are outlined in this book. The newest designs of the electric furnace as applied to the steel industry are given in detail as well as the old on which they are based. The construction and power requirements for steel foundry furnaces are outlined in different chapters, and the use of the electric furnace for smelting also is discussed. A chapter on the production of steel from iron ore and on electric welding is included. The smelting of iron ores for pig iron and their reduction to a state of powder for subsequent melting in electric furnaces is adequately described. The information contained in this work should be valuable to all interested in the production of iron or steel. The author who is Birks professor of metallurgy at McGill university, Montreal, Canada, is properly qualified to treat this important subject in an authoritative manner.

The Buckwalter Stove Co., Royersford, Pa., has awarded a contract to the Beling-Bush Co. Inc., Philadelphia, for the construction of a 3-story carpentry and pattern shop to be complete Sept. 1.

Foundry Costs Simplified-IV

Methods of Establishing Wages Are Explained and Their Advantages and Disadvantages Are Discussed—Standard Time and the Budget System Form Basis of Accounting—Time Studies Made

BY ALFRED BARUCH

IN A JOBBING foundry labor records form the basis for all calculations. As a rule the indirect expense is proportioned to the productive labor hours. When the foundryman estimates on totally new work for which he has no precedent he takes the molding time as the measure of the cost since, barring the cost of metal which is known, the cost of the job will vary in direct proportion to the time spent upon it. Labor records are therefore necessary for the sake of getting a measure for the work and for maintaining control over the jobs to see that the cost does not outrun the price.

The first need in establishing wages is to know how much each molder should do in one day. Once this standard is established, a method of paying wages must be determined. Fundamentally, there are only two ways of paying labor. The first is to pay for the man's services during a fixed period of time. The second is to pay for producing each piece regardless of the time it takes. These two methods are referred to respectively as the day-wage plan and the piece-rate plan of payment. The day-wage plan is usually represented by a fixed price per hour and the other by a fixed price per piece.

The difficulty with the time-payment method is that there is no direct connection between the amount of work done and the wages. Wherever the day-wage system is used supervision must be proportionately greater because there is no fair method by which a man can be penalized for not doing as much as is expected of him. However, there are certain classes of work in the foundry that cannot be put on a piece rate basis because they are too varied. This may be true even in the molding department when castings are few in number and large in size. Again, the foundry workers may not agree to the piece rate under any conditions.

As a matter of fact, the writer believes the piece rate is the fairest method of payment, both for the employer and the employee, provided both parties act in good faith. The simplicity of the method is one of its strongest recommendations. It takes into account the difference between workers so that the most skilled man will get the highest rewards. The method is less expensive because little supervision is required where men get paid on the basis of good castings. It makes estimating on jobs an easy matter.

However, the method has some disadvantages. In the first place, many foundrymen cannot set piece rates properly since they do not maintain production records or make time studies. They cannot determine with any fairness to themselves and to the worker how much a man can do in one day, and therefore how much he should be paid per piece to earn a fair wage.

The ignorance on the part of the foundrymen as to what constitutes a proper day's work is so general that it is necessary to discuss the methods of obtaining this information before going on to the cost records themselves. The two methods most commonly used are production reports and time studies. F. W. Taylor, when he was with the Bethlehem Steel Co., showed the way to increase production by means of time studies. His first step was to remove all

DAILY TIME REPORT

NAME_____

CLOCK NO._____ DATE____ KIND OF WORK____

DEPARTMENT_____ FOREMAN_____

PATTERN NUMBER	MOLDS POURED	QUANITY GOOD	QUANITY DEFEC CORES	QUANITY BAD	HOURS	OFFICE RATE	OFFICE AMOUNT

FIG. 6—INDIVIDUAL TIME REPORT PRINTED ON A CARD 4 X 6 INCHES

DISTRIBUTION OF

DEPARTMENT_____ DATE_____ FO

NAME	CLOCK NO.	PAT. NO. GOOD	PAT. NO. BAD	PAT. NO. HOURS	PAT. NO. GOOD	PAT. NO. BAD	PAT. NO. HOURS	PAT. NO. GOOD	PAT. NO. BAD	PAT. NO. HOURS	PAT. NO. GOOD	PAT. NO. BAD	PAT. NO. HOURS	PAT. NO. GOOD	PAT. NO. BAD
TOTAL HOURS															

FIG. 7—DEPARTMENTAL TIME REPORT MADE OUT DAILY

PAYROLL DISTRIBUTION

CLOCK NO.	NAME	MON.	TUE.	WED.	THUR.	FRI.	SAT.	OVER TIME	RATE	AMOUNT	DISTRIBUTION								
											MELT	CORES	MOLD	S'D BL'ST	CLEAN	REPAIR	JAPAN	INDIRECT	OFFICE

FIG. 8—FORM FOR DISTRIBUTION OF THE DEPARTMENTAL PAYROLL

possible obstacles from the path of the worker. All supplies and equipment were arranged for him so that there could be no delay to the molders or coremakers. For example, the molders did not pour off their own castings but went on making molds while the metal was being poured by a less skilled and lower paid man. Then each man was taught the operations he was to perform. After he had been thoroughly trained and arrangements made so that he could work under the best conditions possible, time studies were made and the piece rates were based on them. This same thing could be done by substituting the daily production reports for the time studies. The difference is that the time studies analyze operations and permit estimating on work that was never done before, simply by a breakdown of the molding to be made.

Combines Two Methods

Another method of wage payment that has been adopted in many plants with some success is the task with a bonus. This is a combination of the two primary methods. The men are paid day wages. They are also assigned a task; that is, a definite number of molds or cores to make for the day. If they make this number or less they are paid full wages. If they make more they are given a bonus of approximately 30 per cent. For example, a molder may be given a task of fourteen molds for the day, which would mean approximately two molds an hour for him. For these he gets paid at the rate of 75 cents per hour. If he should make sixteen molds that day he would get 25 cents extra. This plan assumes that a man ordinarily works at about 67 per cent efficiency and that by proper stimulus he could be brought up to 100 per cent. This plan requires a good deal of clerical work. Besides, it is only a variation of the piece rate method except that it does not give the man everything he earns. However, it is an excellent plan where the work requires constant changing from piece rates to day wages.

Labor records have two important functions; the first is to establish the cost of production, and the second is to account for labor time and wages. The first feature provides the basis for estimating the work and for control over cost and production. The second takes care of the payroll. Consequently, the mechanism that is devised to secure the information as to labor operations and the payroll must have these two functions in view. Aside from this, the only consideration is a way to design records that will be suitable to foundry work.

Where day wages are paid exclusively it is possible to register automatically the length of time the men spend at their work by installing a time clock or any of the other mechanical devices that are now in use. This would satisfy the payroll but it gives no indication of what the men did while they were there nor what the labor costs of the jobs were. Other means must be used, and the time clock becomes merely a check for the payroll.

Three methods are available for keeping foundry labor records. One is the individual daily time card; another, the individual job card; and the third is the daily time sheet made out by the foundry clerk. The daily time card, Fig. 6, is a separate card for every man showing the jobs he worked on and the time spent on each. It shows the man, the date, the department, and the clock number. The body shows the pattern number, the number of molds poured, the number of good castings, the number of defective cores, the number of bad castings, and the time. The bottom of the card shows the rate, the total pay, and the clerk's check. The edge of the card has a time scale so that the foreman may punch the length of time each job took.

Reports Separate Job

The job card, as its name implies, reports a separate job on each card. In this way it is possible for a man to work on two or more jobs in one day and to have to make out two or more cards. As a general rule only a few of the men will work on the odd jobs and the rest will do straight work. These few will have more than one card to make up each day but the rest will have only one. As a result of this method it will be possible to charge each job with its labor costs by merely arranging the time cards according to job numbers. This card must show

TIME

MAN_____NO. OF PATTERNS_____

NO.	PAT. NO.			PAT. NO.			PAT. NO.			PAT. NO.			PAT. NO.			TOTAL
BAD	GOOD	BAD	HOURS	GOOD	BAD	HOURS	GOOD	BAD	HOURS	GOOD	BAD	HOURS	GOOD	BAD	HOURS	HOURS

NDRY CLERK AS SUBSTITUTE FOR INDIVIDUAL REPORTS

the worker's number, the date, the floor or work place number, the core-box number, the job number, the number completed, the number of defectives, the number still to do on this job, the number of gates, the total pieces good, the total elapsed time, the rate, the amount, and the foreman's signature. Although this is an excellent method for getting the job labor costs, it involves much clerical effort, as may be seen.

Simpler Method

A simpler method that accomplishes the same end is the time distribution sheet made out by the foundry clerk. This is a wide sheet, as indicated by Fig. 7, containing the names of the workers for each department down the length of the sheet and sections, headed by pattern numbers, across the width. These sections are subdivided into columns which are headed *good*, *bad*, and *hours*. This sheet also shows the man's rate and thus makes it possible to find how much he has earned each day by adding the number of hours in line with his name and multiplying the total by his rate. The total time chargeable to each pattern will be found at the bottom of the sheet after the column has been totalled. If it is desired to express this time in terms of money, it is necessary to multiply the hours by rates differ, the hours that each one man works on one pattern and their rates differ, the hours that each one puts in must be multiplied by his own rate and the result added to that of the others. However, even this extra multiplication can be eliminated by the use of standard rates which will be discussed later.

The foregoing takes care of the charges to the individual job. In crediting the man with his time the entry was made on a payroll sheet, Fig. 8, specially designed to suit the purposes of the foundry. This sheet contains the man's name and his clock number. It shows the number of hours he has worked on each day of the week. These hours are totalled horizontally and in the next column multiplied by the rate so as to give the amount of wages due him at the end of the week. The remainder of the sheet is divided into columns indicating the distribution of the time, as office salaries, general labor, melting, coremaking, molding, cleaning, sandblasting, etc. These columns are totaled at the bottom and their sums should equal all the salaries and wages paid that week. This information is kept in a special time book with loose leaf sheets and is not a part of the general book. The only entry to be made in the latter is a charge to the payroll account and a credit to cash.

The foregoing discussion has presented all the possible methods for reporting the time of labor and getting the cost of operation on each job. It is not advisable to have the men fill out their own time reports. They usually resent any clerical work as being something outside of their duties. Besides, their reports are unreliable and hardly can be made the basis for charging costs to a job. It is best to have the foundry clerk make out the time reports himself. He is familiar with the patterns on the floor and can get an accurate report, especially if he uses the Distribution-of-Time sheets described here.

This makes no provision for the time spent on operations in each department the job goes through. For melting, all jobs take the same operation, but other departments will work more or less time on each casting depending on its complications and its construction. This information is required chiefly as a basis for estimating on future work. This requires setting up of a standard rate of production which can be used for charging jobs as well as for estimating. This standard is arrived at in two ways:

1. Time studies made with a stop watch.
2. Time studies made by special reports.

Time studies made by a stop watch are by far the most scientific. They record the individual motions and the length of time required to make each one. The total of the times required for the separate motions make up the time for a complete operation. A series of these studies would establish definite standards which, with a margin for safety, are bound to be right. The other set of time studies can be made by special reports. Whenever a job is large enough to have many castings of the same pattern, it is possible to make a rough time study and check it against the run. This would give the time required for that type of casting with fair accuracy.

Charge Job Automatically

After building up a set of standards for each operation, the job is charged automatically with the standard time and the standard labor cost regardless of actual reports or conditions. The theory behind this method of charging time to the job is that any loss in time occurring on one particular job should be charged to all jobs unless it is known that this loss of time was caused by the peculiar nature of the job itself. It will be found that by charging each job with the standard rate no loss from labor is incurred during the year and all the trouble of individual time reports is eliminated.

To illustrate this method the following example is given: Suppose an order is taken that calls for castings of ten different patterns; the bookkeeper would at once charge the job with the standard labor rate and the standard burden rate for each type of work. Now it may happen that the whole job takes less time than the standard allowed for it. In that case the balance between the actual and the standard time can accumulate as a reserve against jobs that require more than standard time. This reserve, of course, is expressed in terms of money.

Jobs Budget Costed

This method of charging a job is known as budget costing; that is, each job is placed upon a budget and made to keep within its limits. But in case it exceeds it, that particular job is not made to pay the penalty since it in itself is not at fault. The loss is distributed over all jobs or else it serves as a charge that has been accumulated from jobs that took less than the standard time. This is the only way possible to standardize labor rates in a jobbing foundry. There are so many variable elements in the foundry that it is necessary to strike a low average and stick to it when estimating. The standardization of rates means the standardization of operations and this invariably produces lower costs.

When individual time cards are used for each job the same procedure as in the case of the time sheets is followed. The time on the card is entered on the payroll sheet and then the cards are filed behind their order numbers in a special file maintained for that purpose. This is a simple way of collecting all the labor charges against a job since all cards bearing the job order number, or pattern number, are collected behind that number in the file and, as they have already been charged to the payroll, these cards can be extended and totaled at the time when the cost of the job is being determined or a financial statement is being drawn up.

Producing Steel Castings-III

Occurence, Treatment and Mixtures of Molding Sands Described and Outstanding Points of Molding and Cleaning Equipment Touched Upon— Different American Specifications Reviewed

BY R. A. BULL

IN ANY general discussion of steel foundry practice reference to the subject of molding sands is advisable. Contrary to the condition in Great Britain, American steel foundries, in the great majority of cases, use synthetic sands. The base of these sands is generally a sand having rounded grains, analyzing, from 94 to 99 per cent silica. Large deposits of such sand are found in numerous locations in the eastern and middle-western states. In the extreme eastern section there has been developed a deposit of sand sufficiently high in silica content, and yet carrying enough natural clay of the desired qualities, to make the sand suitable for some steel molding purposes without the supplementary introduction of any ingredient that nature has not supplied. This deposit is of unusual character as compared with American sands in general. In the extreme west there have been developed practically no sand deposits of consequence well suited to steel foundry operations.

The conditions referred to have necessitated much attention to the design and operation of sand-mixing equipment. Such equipment consists of two general types, one being that of the pan, with revolving mullers or rollers; the other being of the barrel type, horizontally set up, with paddles or blades revolving on a shaft extending the length of the cylinder shell. The pan type of mixer is much the more common one in use. The pan itself is circular, generally varying from 6 to 10 feet in diameter. Sometimes it is held stationary, while at other times it is revolved. In most cases two mullers with intervening plows are employed. These mullers are of varying width, and, as applied, have flat treads unlike some found abroad.

Hoppers Receive Mixtures

Elevating hoppers are now used with pan mills for receiving the ingredients of the sand mixture while a charge is being milled in the pan. As soon as the pan is empty the hopper into which the ingredients have been introduced is mechanically lifted and dumped into the pan for mixing. In some types of mills that have stationary pans, the sand, after mixing, is quickly dumped through an opening in the bottom of the pan, which is closed by a hinged door during the mixing operation. In certain kinds of mills with stationary pans, a section of the pan side is made as a hinged door to serve the same purpose. Where the revolving pan is used, an adjustable plow is often introduced over the side of the pan to deflect the milled sand and empty it over the side.

Milling time in the pan ordinarily consumes not less than 3 nor more than 10 minutes per batch, but is rarely regulated by the clock. In most cases the mill operator regulates the time for the operation by a fist test, or by the apparent strength and moisture of the mixture as his sense of touch permits him to judge.

In most American steel foundries a fairly large percentage of the old or heap sand is used in the regular facing, or sand prepared for ramming directly against the pattern. The portion of such used sand in the facing varies in accordance with the class of work being produced and the ideas the individual foundryman has as to the proper composition of the mixture. His judgment is influenced partly by the delivered cost of new sand, or in other words, by the proximity of his source of supply. Probably the proportion of heap sand used in most American steel foundries for the general run of work produced, ranges from 25 to 50 per cent. Despite this extended use of old sand, more than 50 steel foundries answering a questionnaire recently reported consumptions of new sand that averaged 1400 pounds per net ton of castings produced.

Fireclay is almost universally used for imparting cohesiveness to the mixture intended for facing. There are many clays in use that are quite suitable for his purpose, whose melting point will average 1500 degrees cent. Many clay producers who serve steel foundries, in recent years, have delivered their product in a finely pulverized condition to the great advantage of the steel casting industry. It is generally recognized that a dry binder is most effective when added to the sand in a finely divided condition. Steel foundries frequently add to the facing mixture some farinaceous product, generally made from corn or wheat, which has cohesive value and at the same time is generally believed to impart peeling properties to the face of the mold. An opinion held is that this material goes int rapid combustion when in contact with the molten steel; and that a gaseous envelope is formed by this combustion, which tends to protect the less refractory ingredients in the face of the mold, to the final advantage of the casting from which the sand is believed to strip or peel more readily.

Temper with Molasses Water

To temper the facing in the mold, water alone is added, or water thickened with a small proportion of molasses or a substitute therefor. This substitute is purchased under various trade names and is generally a by-product of the wood pulp indutsry. Its bonding strength is about one and one-half times that of molasses, when used in conjunction with silica sand.

During the last few years a great deal more attention has been given the study of molding sands for all foundry purposes in America than was formerly the case. The most significant development in this study has been the formation of the joint committee on molding sand research, organized by the American Foundrymen's association with the active co-operation of the National Research council, the American Society for Testing Materials and various government bureaus and departments, including the bureau of standards. This committee includes representatives of every phase of industrial and scientific work which is related to the subject. During the last year and one-half the joint committee has been vigorously attacking problems related to the testing of molding sands for the purpose of establishing standardized methods of tests. At this writing, methods for essential tests to determine bonding strength, permeability, and fineness; and methods for supplementary determinations relating to dye absorption and complete chemical analysis, are practically ready for tentative adoption for one year's trial

throughout the American foundry industry. A comprehensive method of sampling sand also has been prepared. As a result of the joint committee's activity many geological surveys have been planned to develop new deposits of molding sands. One phase of the committee's activity of an important character relates to conservation and reclamation. The author suggests the future scrutiny of British steel foundrymen to the committee's reports presented at the 1923 convention of the American Foundrymen's association.*

Equipment Rugged

Description of molding equpiment used at home and abroad either in the form of technical papers or in circular matter disseminated by sellers of such equipment have been sufficiently elaborate to make unnecessary extended mention in this paper. Considering the widely diversified nature of the steel casting industry, the equipment in its various forms represents a large number of devices, many of them highly ingenious and extremely useful. Factors which have been properly regarded by the most intelligent manufacturers of such equipment in the United States are those of ruggedness and ability to stand the excessive wear to which such devices are generally subjected as part of the equipment in a steel foundry. Wherever it has been practicable to displace manual labor and to substitute therefore a squeezer, pneumatic rammer, jar rammer, or other type of machine for compressing the sand, the substitution has been considered and often effected, in the average American steel foundry.

In such foundries specializing in small castings, and shanking the metal by means of pots carried by hand, the squeezer machine is an important piece of equipment. For floor work the pneumatic rammer has demonstrated itself to be of much value in a lessening of manual labor and in great flexibility, applicable irrespective of the nature of pattern equipment or the number of molds to be made from a pattern. The jolt machine, or jar rammer, during the last 15 years has justly become popular. It was developed many years before that but for some time received inadequate recognition. Vibrators to facilitate pattern drawing rollover devices for the more satisfactory and rapid use of molding machines, and other improvements in components of molding equipment, have been developed to a great extent within the last 10 years. More recently other types of molding machines have been patented which are of material assistance not only in ramming but in handling the facing for this operation. Some of these more recently developed items of molding equipment are of special application to the making of castings requiring a considerable flask area, and ordered in large quantities at one time.

Naturally the specialization particularly significant in the basic open-hearth foundry has reflected itself in the engineering skill wisely directed to molding equipment for its classes of duplicate work. So successful have been efforts in this direction that superiority of the castings produced has attended rapidity of production. As a simple economical combination for the production of open-hearth specialties in cast steel, the plain stripping machine permitting the pattern to drop through the plate, and the pneumatic rammer represent very common practice in the United States.

Related directly to the quicker production permitted by machine molding are the delivery of the facing and backing sand to the machine, the delivery of flask equipment to the molders at a speed permitting satisfactory continuous operation of the machine, and conveyance from the molders' working floor, of the molds after finishing and closing. These operations must be satisfactorily synchronized to obtain the full benefit of equipment for rapid molding. It frequently happens that the delivery of sand and flasks to and from the molding floor constitute a problem which requires much more thought and a much larger expenditure of money for equipment than are needed for the operation simply of ramming the sand. The extent to which such production problems have been worked out in some American steel foundries devoted mainly to the manufacture of duplicate work, is highly interesting, and indicative of the fact that mechanical engineering has a large part in the operation of such plants.

Operations Synchronized

In the jobbing steel foundries in the United Stated there necessarily has been less of this development. However, the average foundryman in such plants is alive to the economical advantage of much molding machine equipment at present available to him, by means of which he may displace manual labor to considerable extent in the production of short jobs, or pieces ordered in small quantities at one time.

The development of mechanical devices for molding in the United States has been pronounced during the past 20 years. It has been progressive with each year, but the growth was naturally at an accelerated rate during the world war. It is safe to assume that the design and construction of labor saving equipment for molding purposes in America will continue at a rapid rate for a long time to come, and that we will see 10 years hence a further significant advance, through the application of great engineering skill now directed to the study of foundry problems.

Core Room Backward

The installation of scientific methods characterizing molding operations has not been paralleled by similar progress in the core room, in American steel foundries. The steel casting industry seems to have labored under somewhat the same handicap as has afflicted other branches of the foundry industry in the United States, in inadequate attention given to core practice. Significant exceptions to this rule are of course found where steel and other castings are produced. These indicate to the intelligent observer the present availability of considerable equipment that can be economically employed, for preparing the core sand, for ramming the cores, for baking them, and for storage and transportation.

It may be truthfully said that while the industry as a whole has not paid adequate attention to coremaking, the operation of ramming the sand in the corebox has been developed with reasonable success in the average American steel foundry, simultaneously with considerable neglect in the selection of core sand mixtures and in the baking of the cores.

There is much yet to be done in determining the best materials to employ core mixtures for various classes of work. These include the sand used as a base, and the green binder; and the permeability of the core; the relatively important skin of the core, and the many other considerations involved in baking the cores. There is considerable difference of opinion regarding desirable fuels for core ovens, temperatures to employ, periods of time for drying at designated temperatures, and circulation of heat in, and insulation of core ovens. Some steel foundries have been carrying on extended investigations into this subject with resulting economies in progressive degree.

The average steel foundry in America uses a considerable quantity of silica sand as the base for most of its core mixtures. Some such foundries also employ sands not containing a high silica content, but characterized by a slight amount of cohesiveness due to the presence of a natural clay substance. It is the practice in most plants to use a considerable portion of heap sand in core mixtures not

*These reports will be found in Vol. XXXI, to be subsequently issued, of the *Transactions* of the American Foundrymen's association.

bonded with oil. Sometimes the refuse from sandblasting is introduced into the core mixtures.

The use of oil as a binder for core sand is observed more in steel foundries making small castings than where large ones are common. The author believes that in the steel casting industry such use of linseed or other oils is proportionately on the decline, due to a growing more careful discrimination in the use only of high priced materials where the need exists; and to the reasonable success that has attended the manufacture of some classes of work where cheaper core binders than oil have been successfully substituted.

Pitch as Core Binder

In the larger steel foundries there is much pulverized pitch used as a core binder, either in its pure form or as mixed with small percentages of other materials in what are called core compounds. For many classes of work, large and small, pitch has indeed proved to be a highly satisfactory core binder, particularly advantageous in use with considerable percentages of heap sand. In that respect it differs widely from oil, whose function as a binder after drying does not satisfactorily come into play when the sand grain has a coating of clay which absorbs much of the oil without any appreciable benefit in temporarily making the sand grains cohere, as when such grains are clean.

The use of wheat flour in American core sands has been of long duration. In recent years other farinaceous products have been employed to considerable extent as substitutes for it. The employment of any of these materials is often advantageous in reducing the amount of clay to give the required green bonding strength. It is becoming recognized more and more that a heavy proportion of clay in a dried core is disadvantageous in certain classes of work. Substituted bonding materials which go wholly or partly into combustion when the metal is poured are being studied with reference to the volatile matter expelled in such combustion, and the effect this may have in causing porosity in the steel casting.

Equipment and methods employed in cleaning steel castings in American steel foundries are widely varied according to the nature of the work produced. They represent a great deal of ingenuity that has been applied to this relatively expensive phase of steel casting manufacture. Since the nineties there has been a tremendous development in the installation of mechanical devices to take the place of hand chipping and other laborious operations that formerly produced high cost and unsightly appearance of the product as shipped.

In the larger foundries the pneumatic hammer is extensively employed. Circular cold saws are frequently used for the removal of heads or risers on large castings. In many open-hearth foundries, pneumatic chipping hammers, cold saws, grinding wheels, sand-blasting apparatus, hydraulic presses for straightening, and welding equipment constitute practically all of the cleaning facilities. Foundries specializing in the manufacture of small steel castings generally have gas torch equipment for burning off gates and heads or risers, swing and stand grinding machines, apparatus for blasting with sand or a metallic substitute, pneumatic chipping hammers, tumbling barrels and welding equipment. Facilities for welding in the industry as a whole include apparatus for performing the operation electrically and by means of gas. Difference of opinion exists regarding the relative effectiveness of gas and arc welding. This is probably due to difference in the skill of operators. The author's experience has indicated the effectiveness of either method of welding in careful, experienced hands when proper equipment is used. Under those circumstances electric welding is the cheaper.

The sequence of cleaning and finishing operations in any foundry is appropriately given serious consideration, and should be decided largely by the nature of the work produced. These operations include the important one of heat treating, which is mentioned later.

The extent to which thorough cleaning methods are applied to steel castings varies perhaps more than any other detail of such manufacture, except melting. However, cleaning requirements, have considerable to do with molding and core practice, which are properly regulated to a large extent by the desired surface appearance of the product. Reference has been previously made to what is in the United States a marked differentiation in the surface finish. This factor has caused a great refinement of cleaning operations to be adopted in many steel foundries specializing in the manufacture of small castings.

Stimulus to Heat Treatment

The world war provided a great stimulus in the heat treatment of steel castings made in the United States, through the exacting physical tests for much ordnance work. Many foundrymen learned much of value regarding the effects of scientific heat treatment. The depression in the industry which was marked in 1921 stimulated some steel foundrymen to improve their heat treatment methods to even greater extent that was done during the war. There is now a great interest in this subject in the industry and among users of steel castings. Researches are being conducted in many plants, and as a result many highly important facts are being established. Among those which have hitherto been misunderstood or practically disregarded, is the effect of the rate of cooling after heating in the annealing oven.

It may be appropriately explained here that engineering phraseology in the United States now classifies under the term heat treatment any method of heating and cooling for the purpose of refining the structure. The word annealing is now used generally to define such heating when it is followed by a cooling operation in the oven. The term normalizing is employed to mean such heating when it is followed by cooling in the air. The term heat treatment as now used does not imply necessarily a secondary heating, and has a general, not a specific interpretation among American metallurgists.

Pyrometers Employed

Ovens used for heat treatment in American foundries are called annealing ovens. In most of these annealing ovens, pyrometers are installed. The fuel used for such ovens is selected according to the location of the plant and the availability of suitable coal, fuel oil, and gas either natural or artificial. The annealing cycle varies tremendously according to the thickness of section. Probably the range is between 6 hours and 9 days. The period last named is employed for the complete operation in the case of cast-steel rolls of diameters up to 48 inches.

An interesting development taking place during the past few years has come to public notice within the past 12 months. This is regarding more exacting requirements for the physical properties of American-made steel castings. For a considerable period up to June, 1922, commercial specifications for the soft grade of carbon steel castings called for the following as minimum tensile-test values:

Ultimate strength per square inch..60,000 pounds
Yield point 45 per cent of ultimate strength
Elongation in 2 inches.....20 per cent
Reduction of area.....30 per cent

Minimum values consistent with those enumerated for soft steel were prescribed for medium and hard steels.

Following a well defined desire for more exacting specifications, expressed by consumers of high grade steel cast-

ings for railroad use, in which producers of such castings indicated a reasonable degree of acquiescence, a joint committee was formed to represent the American Society for Testing Materials and the American Railway association. This committee conducted a large number of tests following which it reported to the parent organizations. The result finally was the adoption in June, 1922, by the American Railway association and by the American Society for Testing Materials, of tentative specifications for carbon steel castings for railroad use which call for the following minimum tensile-test values for the annealed soft grade:

Ultimate strength per square inch..not specified
Yield point per square inch.....1,600,000
Tensile strength
Percentage of reduction of area.....2,600,000
Tensile strength

The specifications stipulate that the elongation in 2 inches shall not in any case be under 24 per cent, and that the reduction of area shall in no case be under 35 per cent.

It is significant that minimum values for ultimate strength are not specified, and that the actual tensile strength must be determined, according to these tentative specifications, simply to ascertain by the formulae the minimum figures for elongation and reduction of area. Values intended to be consistent with those for the annealed soft grade referred to in the foregoing were established for one harder grade. The term annealed was embodied in these specifications in place of the better one, heat treated. The tentative adoption of these specifications means their use on trial for one year from such adoption. It is, of course, optional with any consuming member of either association concerned in the formulation of these tentative specifications to purchase railroad steel castings in accordance with these requirements. They will not have the strength back of them in influencing the steel casting industry that will result, if and when satisfactory use of them as tentative has shown the desirability of making them permanent or standard. The elimination of minimum tensile strength values is the result of a growing disposition among railroad engineers who design steel castings, to regard the yield point as of paramount importance, compared with the ultimate strength, in establishing the proper factor of safety.

Tentative adoption of much more exacting requirements for physical properties in steel castings for railroad has naturally had its effect in causing producers and consumers of steel castings for other uses to scrutinize current specifications, with the idea of making them more in conformity with the better results in practice now being obtained, as compared with the results previously secured when the industry was under less scientific control. At the annual meeting of the American Society for Testing Materials to be held in June, 1923, revised specifications for steel castings for general use will be submitted to the Testing society by its committee on steel which has, through a subcommittee, given a great deal of study to this matter during the current year. It is premature to indicate with any exactness what the requirements will probably be after consideration by the entire personnel of the Testing society. The author can safely offer his opinion that the requirements for the soft grade of carbon steel to be tentatively adopted will call for an increase in the percentage of elongation and in that for reduction of area above the figures (22 per cent and 30 per cent respectively) now regulating the purchase of much cast steel for ordinary use; and that for such ordinary use, it will not be considered advisable to eliminate the minimum value for ultimate strength in tensile testing. The probability is that a greater increase proportionately will be required in the value for reduction of area than will be demanded for the elongation.

Make Exhaustive Tests

It may be noted that the term yield point has been used throughout the references to standdard and tentative specifications. The joint committee on tests, representing the American Society for Testing Materials and the American Railway association, was confronted by a desire on the part of certain railroad engineers to make the true elastic limit the basis for revised specifications. After the most exhaustive precision and running tests, it was conceded that the present state of the art of testing provides no satisfactory instrument which, when properly used, gives consistent results to determine the true elastic limit of cast steel. Experimenters who have made many tests on steel castings and steel forgings have found a considerable difference in the behavior of the two kinds of steel in this respect. Instruments are manufactured which indicate with satisfaction, the phenomenon that follows strain beyond the true elastic limit of steel as forged. Considered from the standpoint of instruments that have been thus far developed, it may be said that steel as cast has no true elastic limit, although it has a well defined yield point, determined by the drop of the beam of the testing machine, or by the use of dividers.*

From preceding paragraphs it may be seen that physical requirements of an exacting nature not only demanded by American industry but are capable of being satisfactorily met in routine operations in American steel foundries. The large representation of steel founders in the organizations whose functions are to formulate specifications makes this point clear.

Specifications which have been in force for some years covering the manufacture of ordinary steel castings have sometimes called for bend test requirements for soft castings. These provide for the bending cold of the specimen through 120 degrees around a pin 1 inch in diameter, without cracking on the outside of the bent portion. The specimen is machined to measure 1 x ½ inch with corners rounded to a radius not over $\frac{1}{16}$ inch. The tentative specifications for carbon steel castings for railroads do not call for a bend test. The general specifications to be submitted for revision to the Testing society by its committee on steel will probably include an optional provision for a bend test, since such a test is strongly favored by a few consumers such as the United States Navy. Recently a great deal of study has been given to the subject of bend testing, and it is probable that as a result explicit instructions will be embodied in specifications at some future time regarding the manner in which a bend test shall be made. It has been determined that the manner of making the bend has much to do with the result of the test. Other conditions than those covering the section of the bend piece and the radii of the corners should be imposed.

Specifications for steel castings in use in the United States have included certain requirements as to chemical analysis. The present standard specifications of the American Society for Testing Materials for steel castings call for the following:

	Class A per cent	Class B per cent
Carbon	not over 0.30	.....
Phosphorus, acid	not over 0.07	not over 0.06
Phosphorus, basic	not over 0.06	not over 0.05
Sulphur	.....	not over 0.06

Class A castings as referred to in the specifications mentioned need not be annealed unless so specified, and are intended for purposes justifying no physical requirements. Class B castings are those which are graded according to hard, medium or soft condition for which physical requirements are stipulated. The maximum limitation

*Proceedings of the American Society for Testing Materials, vol. 22, part 2, pages 150 to 171, "Tensile Properties of Steel Castings." By I. H. Fry.

ANALYSIS OF LIMESTONE

By J. W. Bolton

Limestone finds its principal use in the foundry as a flux. It is added to the cupola charges to flux off the sand, oxides, sulphur, etc., and to keep the cupola in good operating condition. Some forms of limestone, such as calcite, are almost pure calcium carbonate. The dolomitic limestones contain considerable magnesium carbonate in place of calcium carbonate. All limestones contain impurities which lower the fluxing power. The main ones are silica, SiO_2, and alumina, Al_2O_3. Iron oxide, Fe_2O_3, also is counted as an impurity. The siliceous impurities come from quartz, and clay or other silicates which occur mechanically imbedded in the limestone. In addition limestone contains small amounts of sulphur, probably as FeS and $CaSO_4$, and small amounts of phosphoric acid, P_2O_5.

The major reactions of limestone in the cupola are as follows: The stone is decomposed to lime at high temperatures, according to the reaction: Limestone, $CaCO_3$ plus heat changes to lime, CaO, plus CO_2 (carbon dioxide). The lime then unites with silica somewhat according to the typical reaction: CaO plus SiO_2 forms $CaSiO_3$, calcium silicate.

The foundryman is principally interested in the total impurities which should be under 5 per cent, and the amounts of *lime*, CaO, and magnesia, MgO. The following method is adapted to the laboratory which has only an occasional limestone to run. It is accurate, simple, and does not require preparation or maintenance of special solutions.

Sampling—As in all analytical work, proper sampling is essential to representative results. Limestone shipments vary somewhat in form, uniformity, etc., therefore, the chemist must be guided by his experience in sampling, and by common sense. The final laboratory sample is ground to 60 mesh or finer.

Analytical Method

Procedure—Mix 1 gram sample well with 1 gram of sodium carbonate, Na_2CO_3, and fuse in a platinum crucible, avoiding spattering. Dissolve fusion in HCl (1 to 1) and evaporate to dryness. Add about 5 c.c. conc. HCl and 25 to 35 c.c. hot water. Filter off silicic acid, washing well with hot dilute HCl (about 10 per cent of conc. HCl) and hot water. Ignite in platinum crucible and weigh silica. Weight of silica x 100=per cent SiO_2 (silica).

Add slight excess ammonia, NH_4OH, to the filtrate; i.e. until filtrate is distinctly ammoniacal. Boil until hydroxides of iron and alumina become coagulated, which will require about 5 minutes. Filter, washing the precipitate well

(*Concluded on Data Sheet No.* 488)

ANALYSIS OF LIMESTONE

(*Concluded from Data Sheet No.* 487)

with hot water. Ignite precipitate to sum of iron and aluminum oxides plus phosphorus and titanium oxides. Weight of oxides x 100=per cent iron and aluminum oxides.

Make barley acid with HCl using nethyl orange or litmus as an indicator. Heat to boiling and add 20 c.c. hot oxalic solution, containing 5 or 6 grams solid oxalic acid. Add strong ammonia in small amounts until mixture is strongly ammoniacal. Then add 2 or 3 grams ammonium oxalate dissolved in a small amount of water. Allow precipitate to settle about 2 hours. Filter through a close texture paper, washing well with hot dilute ammonium oxalate solution. Ignite to constant weight in a porcelain crucible in muffle furnace. Weight of precipitate 100=per cent CaO, (calcium oxide). Weight of precipitate x 179.0= per cent $CaCO_3$ (calcium carbonate).

Boil filtrate until excess ammonia is driven off. Make slightly acid with HCl and add 20 to 25 c.c. of a solution containing 4 or 5 grams sodium or ammonium phosphate. Add about 1-10 of the solutions volume of conc. ammonia, stir well, rubbing sides of breaker with glass rod. Allow to cool, then filter. Wash well with hot water containing a little ammonia. Ignite paper and contents, slowly at first, to whiteness in muffle furnace. Weight of precipitate x 36.2= per cent MgO on 1 gram sample. Per cent MgO x 2.08=per cent $MgCO_3$ (magnesium carbonate).

Notes and Precautions—The determination of silica is accurate enough for all ordinary purposes. For extreme accuracy, re-evaporate filtrate, and volatilize silica with hydrofluoric acid.

For rough work, dissolve sample in HCl, evaporate, take up in dilute HCl, add excess of ammonia, and filter off silica, aluminum hydrate, and iron hydrate, and ignite. Weight of precipitate x 100=per cent impurities. This method is a little shorter than the one advocated and is for approximate work only.

For accuracy on high magnesia limestones it is necessary to make a double precipitation of calcium. For laboratories running many limestones the calcium is most conveniently determined by permanganate titration of the oxalate.

Sulphur and phosphorus may be determined in the carbonate fusion by any of the standard methods. These determinations are rarely of great value for foundry work.

THE FOUNDRY DATA SHEET, AUGUST 1, 1923
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

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May 26, 1923.

THE FOUNDRY,
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Attention: Mr. J. D. Pease

Gentlemen:

On this, the 49th anniversary of the founding of this business, we look back over the years of growth and development for the potent causes for results, and are pleased to say that outstanding among them is the benefit we have derived from the advertising pages of THE FOUNDRY which we have used continuously since its appearance in 1892.

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THE W. W. SLY MANUFACTURING CO.

Per: [signature]
President

SCV:HH

Sly stands for - Standardization, Service, and Satisfaction

for phosphorus and sulphur mentioned in the table may be exceeded, according to the terms of the specifications referred to, by not more than 20 per cent.

The tentative specifications for carbon steel castings for railroads adopted in June, 1922, call for a maximum limit in manganese content of 0.85 per cent for either grade covered by the specifications; and a maximum limit for phosphorus, as well as for sulphur, of 0.05 per cent, without qualification. Most, if not all, of the steel foundrymen supplying railroad and other castings, and some railroad engineers, believe it is unscientific to establish such a maximum limit as has been imposed for manganese content. The author is in entire agreement with the objection, founded, as he believes it is, on reliable metallurgical data and comprehensive reports on many steels in service. It seems unlikely that any maximum limit for manganese will be proposed for the expected revision of current specifications for carbon steel castings for general use, at the convention of the American Society for Testing Materials to be held in June, 1923, since an increasing and large number of metallurgists and engineers associated with producers and consumers of steel castings feel that the manufacturer should be permitted to regulate the chemical composition of metal, when called upon to meet definite physical requirements. This opinion prevails with natural exceptions regarding the elements of phosphorus and sulphur, each of which occupies a different position in the influence exerted on the physical properties.

Close Co-operation

Since the specifications adopted by the American Society for Testing Materials are the basis upon which practically all consumers' specifications in use in the United States are formed, it is unnecessary to enumerate requirements in other specifications than those mentioned in the preceding. There is a close co-operation between the American Foundrymen's association and the American Society for Testing Materials which brings the organization first named into conference, through designated representatives, in all committee activities of the Testing society that relate in any important way to the foundry business. The friendliest feeling exists between these two important organizations which have a combined membership of more than 4500 men prominent in the manufacture or testing of engineering materials.

Instead of praising the quality of metal in steel castings produced in the United States, the author prefers to submit the facts already mentioned indicating the requirements exacted by engineering practice in our industry. These requirements may be compared with those in other countries to the relative credit or discredit of the industry wherever located, on the fair assumption that average results obtained in daily practice necessarily exceed the minimum requirements called for, by reasonable margins.

Industry Specialized

In the first part of this paper the author took care to point out the great extent to which the steel casting industry in the United States has become specialized. That fact can only be realized satisfactorily by visiting a large number of steel foundries in a wisely selected, broad area of territory. Perhaps some appreciation of this condition will be gained from the brief mention of many details of practice in previous pages. It is hoped that an erroneous impression may not prevail in some foreign countries regarding effects of what you term *mass production* and what we call *quantity production*. The author, as a regular reader of British literature treating of the steel casting industry, noticed with much interest some months ago, a series of articles in one of your publications by an American friend who endeavored to explain for your better understanding, what is really the result on the product, of quantity production in properly regulated foundries in the United States. The exposition was made by one who is well informed regarding American foundry practice and who, if one may judge from the nature of his occupation during several recent years, should be fairly familiar with foundry practice in the British Empire and on the continent of Europe. His opportunities for making current comparisons should outweight his national prejudices. The opportunities the writer of this paper has had for similar comparisons have been quite limited, but have included examination of numerous foreign-made steel castings during the world war. Reasonable allowance for inferiority due to stress of war times is conceded. In the light of the limited knowledge of the author and the much knowledge of many of his acquaintances regarding the product made overseas, the writer feels justified in cautioning against an opinion that might be inadequately based, that the general average of steel castings made either in the United States or in Canada is of lower quality than that representing the product either of the British Isles or of the European continent. The author's purpose in saying this, is in no sense to start a controversy which by the very nature of the case could not be easily settled, if at all; but to assist, if possible, in the most satisfactory interchange of helpful views based on experience, and on sound hypothesis as to existing conditions at home and abroad. There is much that each of us can learn from the other when mutual respects for genuine accomplishment exists. We in America can profit by the study of your painstaking detail, resulting from a craftsmanship that has been long in the making. You as a group can benefit by the scrutiny of our time-saving methods, employed both in quantity production and in the manufacture of short order jobbing work. When both of us combine the best methods employed by each of us to the extent that local conditions permit, the English speaking steel foundryman at home or abroad will have made much more progress than that of which he can boast today.

Recommends Book

Perhaps every writer who attempts to discuss briefly a large subject always approaches the end of his task with the uncomfortable feeling that his treatment of many details may be out of proportion with their actual significance. Whether or not this feeling generally exists, the author of this paper confesses to the sensation mentioned. If his effort to enlighten his fellow foundrymen abroad should stimulate them to the study of a more complete and far more astisfactory exposition of steel foundry practice in the United States, he would recommend for careful examinaton, an instructive volume devoted to the subject written by a foundryman friend of the author.*

The writer wishes to assure his fellow members of the Institution of British Foundrymen of the hearty co-operative spirit toward them, of his closer associates in the American Foundrymen's association. In the United States we watch with genuine interest and satisfaction your increasing growth. We cordially welcome your members to our foundries when on our shores. We congratulate you sincerely on being directed from time to time by those able past presidents of your Institution whom we have been so fortunate as to have as guests. In the future we hope to know many of their successors and colleagues, and to aid and be aided by all of you in the most economical manufacture of the best steel castings that can be produced.

The Steel Foundry, second edition (1922), by John Howe Hall.

Bill Explains How Art Work Is Made

BY PAT DWYER

OCCASIONALLY I am invited by the executive head of the family to accompany her on a shopping tour downtown. My duties on these occasions are somewhat light and pleasant in character and as a result of many years experience I think I may lay claim with all due modesty to have developed into a fairly competent traveling companion. Through constant repetition, the shopping program has been standardized and simplified to such an extent that now it merely is made up of two parts. Probably if one cared to go into microscopic detail and insisted on a strict accounting for every 5-minute period during one of the excursions, or if one was minded to draw a chart covering the activities of the day, it is probable that the lines would show lack of coincidence at more than two points, but for all practical purposes, two divisions cover everything.

In the first part I hand over all my money before we leave home. Sometimes under protest and sometimes willingly, but the fact remains that I hand it over and really when you come to think of it, that is the only feature that has any direct bearing on the controversy. In the second part I loiter around the outside of each store in turn until the lady's imagination becomes exhausted and she can think of nothing further to buy.

She has suggested at times that I accompany her into the various stores, but whether the invitation has been prompted in recognition of, and as a slight concession to, my position as the mysterious source of all the available family funds, or because she thinks my presence beside her would supply some slight measure of moral support, I never have been able to determine.

In the early days I was moved—somewhat timidly I admit—to put out what the legal fraternity is pleased to call a feeler in the shape of a gentle inquiry. A duly qualified limb of the law might have derived some information from her reply, but I did not. I increased by general stock of knowledge in some slight degree, but not on that particular point. To all intent and purpose I was as wise afterward as I was before. She told me not to waste my time, or her's, asking silly questions, but if I really wanted to know, she was afraid the dog catcher would run away with me if he saw me hanging aimlessly around the sidewalk in front of the store.

Once in a while I go inside and tramp up and down miles and miles of long aisles, varied occasionally by excursions through side aisles. Jostled and pushed by perfect strangers who in the great majority of cases, I am inclined to think, have as little business in the store as I have. Gradually and in an almost imperceptible manner I become loaded down with a miscellaneous collection of parcels until I begin to feel like the camel illustrated in one of the old school books.

With the laudable intention of eliciting a slight measure of sympathy I directed the lady's attention on one occasion to the analogy. She was not impressed. In fact she was pleased to treat the question with a certain degree of hilarity. She declared that I had many of the camel's attributes long before she had consented to look after me. She rather went out of her way to explain that she had no reference to the camel's alleged ability to go seven days without a drink and left me to wonder if the bandy legs and hump I had acquired in the foundry, formed the basis of her comparison.

ONE REASON WHY IT IS CALLED DUST

While on the subject of camelsI think I am quite safe in claiming that I know exactly how the original camel felt. You know the one which tried to sneak through the eye of the needle. I have tried on more than one occasion to smuggle myself and a miscellaneous load of merchandise through one of these revolving, squirrel-cage doors in the entrance of a big store. I don't know what perverted genius invented this prolific cause of profanity, but I know that I have offered many an earnest prayer—none the less sincere because silent—that the inventor be doomed to an eternity after death in dodging in and out through one. To make the event properly interesting I would have him equipped with a peddlar's pack on his back and have his arms loaded with parcels; parcels I have carried at one time or another.

'Tis said that man wants little here below and I should feel amply repaid for a life of toil if I should win permission in the hereafter to occupy a reserved seat, or even a seat in the bleachers where I could enjoy an uninterrupted view of his activities. It seems almost too much to expect, but the prayers of the righteous avail much and—I have hopes. To quote from one of our well known standard authorities: "It is a long worm that has not a turn."

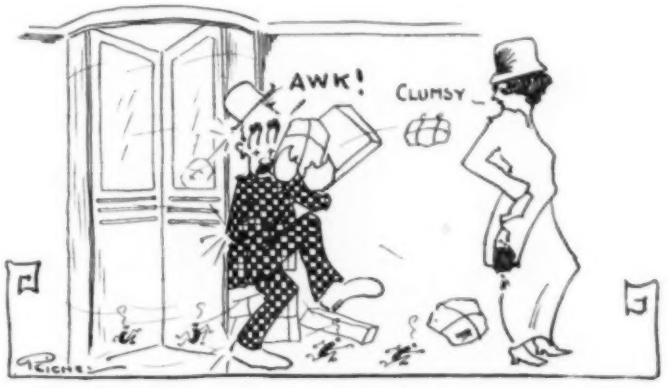
As I said in the beginning, I usually stay on the outside and risk attack, real or imaginary, from the dog catcher.

the pickpocket, the gunman and other industrious gentlemen who make a more or less honest living in the pursuit of their various callings in a big city. Despite the opinion of the lady to the contrary, I feel reasonably safe from the first menace listed and considering the fact that my pockets are empty I have nothing but the liveliest form of sympathy for any of the light fingered gentry who unfortunately may select me for a victim. The position has its advantages including the untrammeled right of any citizen free, white and twenty-one to smoke away as much as he pleases. I also enjoy the spectacle of the hurrying crowds and can speculate, idly on where they all are going and what they expect to do when they get there.

One day recently I departed from my usual rule to the extent that I went in as far as the first counter to the left where my attention was attracted by a display of book ends and other pieces of merchandise. My butterfly companion flitted away from one counter to another but I decided to stay in one place. I felt reasonably certain that the finger of Providence and that wonderful faculty or gift known as woman's intuition, would reunite us before the time for departure. In our early married life I have had anxious moments during brief and temporary separations conjuring up all kinds of accidents and unpleasant experiences into which she might innocently walk while deprived of my sophisticated care and protection. However, as one of our ancient philosophers so truly and aptly observed, age brings experience and leads one to laugh at the folly of his youth. Folly, yes indeed.

There are times when I flatter myself she seeks me out through personal preference. There are other times when I know that expediency directs her choice, but irrespective of which factor is in the ascendancy I knew that on this occasion the inevitable bundle of parcels would drive her to me as truly as the load of accumulated pollen and honey drives the homing bee on its course. The comparison with the bee also holds further in that the journey would not be made until she actually could carry no more.

Many castings on the counter were comparatively plain from a foundryman's standpoint, which means that although in some instances they presented elaborately carved designs, still the entire pattern was of such a shape that it could be molded readily in an ordinary two-part snap flask. Other pieces were



REMINISCENT OF COMING FULL OF RYE

decidedly different. Busts of famous men, pieces of statuary, representations of human and animal figures, reproductions on a miniature scale of historical groups and figures aroused in my mind a profound respect and admiration for their creators. This feeling of admiration included the artist who conceived the design and later transferred it from a nebulous image in his brain to a tangible form of three dimensions and also included the artizan who perfected the process for reproducing the object in practically indefinite numbers and on a commercial scale. Art for art's sake is all right—in its own place—but as collateral or a negotiable medium it never has and probably never shall wrest the crown of popularity from its age old rival, sometimes I regret to say referred to flippantly as the root of all evil.

I had no intention of buying any of the objects displayed so temptingly. Temptingly is the proper word to use in this connection for if I did not break the tenth commandment, I am afraid I dented or otherwise bruised it to a considerable extent.

For the benefit of the curious I may say that I can enumerate at least a dozen good and sufficient reasons that prevented me from purchasing any of the goods. First, I had not the price and the remaining reasons really are not of any consequence. I'll admit that they seem rather plausible when a man makes them to himself, but they won't stand publicity. They seem to shrink up and curl out of sight when exposed in their naked simplicity before a second party, particularly if the second party has a rather free or working knowledge of your financial standing and your household habits.

I suppose with a little practice I might have acquired one or more—among the fraternity I believe the process is known technically as **lifting** or **pinching**—but I lacked the necessary courage and skill and besides I noted that one of the attendants was hovering in my vicinity and if the truth must be told, was eyeing me in a somewhat suspicious manner. Not openly and brazenly, you know, but quietly and discreetly as became the exclusive character of the establishment. I can advance no particular reason why he should have suggested the comparison, but he reminded me of an old battle scarred tom cat we had at one time who would lie for half an hour feigning sleep beside a bird bath waiting for a chance to grab a sparrow.

He was a small, elderly man, the attendant, not the cat, immaculately dressed, with a pair of shining rimless glasses perched astride a little sharp nose and with a few remaining hairs carefully parted on the surface of an otherwise shining little dome.

He finally pussy footed down to where I was standing, rubbed his little mani-

JACOB WAITED SEVEN YEARS FOR RACHEL BUT HE DID NOT HAVE TO CARRY HER PARCELS

cured paws, assumed his regular stereotyped smile and purringly inquired if he could have the pleasure of serving me. I had no desire for his company and did not want to waste his time. I told him frankly that I simply was admiring the display, but at the moment had no intention of making a purchase. He showed no inclination to leave me in peace and acting on an idle impulse I asked him if he was familiar with the process involved in making the castings.

He smiled a little judicious, deprecatory smile with just a hint of a supercilious curl in the corners of his little frosty mouth. If it had not been for that last symptom I might have cut short the interview for I am naturally of a kind and humane disposition and hate to see a man render himself ridiculous. However, since he seemed to assume that I was—to borrow one of Bill's phrases—a poor dumb nut, I decided to let him go the limit and hang himself.

I registered the most profound and earnest attention and was duly surprised and even mildly gratified to learn that the process was quite simple. I carefully refrained from asking any embarraising questions and thereby probably confirmed him in his original opinion of our respective stations on the ladder of general knowledge. In my youth I was taught to defer to the opinions of the aged and I hope he was duly impressed by my attitude on this occasion. For his peace of mind I sincerely trust he was no mind reader.

He informed me that the artist first made a model in clay. This model was finished carefully down to the minutest detail and then baked with the result that it became quite hard. The artist then placed the model on a bench, under a strong light and, taking a block of plaster proceeded to carve out the interior until the cavity became an exact obverse duplicate of the clay model.

Shade of Marse Henry Watterson! My God! said the magpie and flew away. I cannot imagine what the fiery old editor would have said had he heard the remainder of the story.

After the block was finished it was used for a mold. It was filled with liquid plaster which was removed after it had hardened sufficiently. The plaster duplicate of the clay model then was dipped into a pot of boiling metal which formed a thin coating and also perpetuated the shape of the interior. After the metal cooled, the plaster interior was cleaned out and the result was the finished shell casting that is placed on the market.

At one time or another I have heard many nontechnical descriptions of the processes incident to the production of castings, but if ever I hear of a prize being offered on the subject I shall be willing to go a long distance out of my way to nominate my little friend for the honor.

He was just getting warmed up to the second or more important part of his subject when we were interrupted in the manner I had anticipated. The lady approached and said "Let's go." We went. Therefore, I probably always shall remain in ignorance of the mysterious journey taken by a plain little casting between the foundry and the art store, a journey that increases its cost by at least 300 per cent.

Bill came rambling in to the house last night and in the manner made famous by a certain little lady named Alice, we talked of many things none of them of any importance. The talk drifted from one topic to another sometimes totally unrelated, as talk has a habit of doing even in the best regulated families and among other items I brought up the interview I had with the art man. I admitted to Bill that I was not as familiar with the process of producing this class of castings as I was with some others, but I had grave doubts regarding the feasibility of dipping a lump of plaster or any other substance into a pot of molten metal with the expectation of securing an even deposit of metal all over it. Any man, silly or ignorant enough to do a trick of that kind should consider himself lucky if he escaped with out the loss of both eyes and all his clothes.

"All bunk," said Bill. "That poor fish simply was whistling through his gills. You should have given him the hook. The castings are made from a white metal mixture poured in a permanent metal mold. The initial expense of making one of these molds is quite heavy and only is justified in the subsequent long life and enormous producing capacity. One mold will serve for thousands of castings and in that manner the initial expense is absorbed and the expense per casting is comparatively slight.

"A bronze mold in several parts is made from an original plaster cast. The number of parts will depend on the intricate shape of the proposed casting. In many cases the parts are what usually are referred to as drawbacks. The parts are finished carefully and accurately machined on the joints to fit closely together. They are assembled on a base and arranged in such a manner that a pull from one or more levers will alternately bring them all together in their proper relative position to receive the metal; or, separate them a sufficient distance from each other so that the casting may be removed.

"The metal is melted in an iron pot and dipped out with a small hand ladle. Two men usually work together; one handles the ladle and the other manipulates the mold. A considerable degree of skill and judgment is required on the part of the operator to determine the cooling speed of the metal. The finished casting is in the shape of a shell and the temperature of the metal and the time it is allowed to remain in the mold determine the thickness of this shell. Each casting must conform to a uniform and definite weight and all castings above or below this weight are rejected. The mold is filled with metal and when the operator decides that the shell has solidified to a sufficient thickess, the mold is turned over and the liquid metal in the center is spilled back into the ladle and then returned to the melting pot. Usually the elapsed time while the metal is in the mold is reckoned in seconds and therefore it is readily apparent that the judgment of the operator is the most important factor in the cycle of operation. Oh! yes," said Bill in conclusion, "the process is quite simple. Any process is simple if you know how."

Change Company Name

Stockholders of the Carroll Foundry & Machine Tool Co., Bucyrus, O., at a special meeting ratified a change in name to the Bucyrus Road Machinery Co., and also approved an increase in the authorized common stock from 10,000 to 25,000 shares of no par value and from 5000 to 7000 shares of preferred stock of $100 par value. H. D. Jones, formerly with the Buffalo Springfield Roller Co., and later the Galion Iron Works & Manufacturing Co., has become affiliated with the Bucyrus Road Machinery Co. as vice president. Officers and directors of the company are: E. L. Frantz, chairman of the Apex Electrical Co., Cleveland, chairman of the board; W. E. Mathew, president; H. D. Jones, vice president; George H. Lavan, secretary; R. B. Washburn, treasurer; C. D. Frantz and Edward Gledhill.

Appointed Representative

James L. Deiter has been engaged as special representative for the Borne-Scrymser Co, 17 Battery Place, New York, to engage in the sale of core oil. Mr. Deiter has been superintendent of foundries for the International Motor Co. at New Brunswick, New Jersey. Previous to that time he was associated with the Aluminum Casting Co. as coreroom foreman at its Syracuse foundry and later was transferred to the plant at Fairfield, Conn. He has been engaged in the foundry business for a number of years starting with the Power Co., Dansville, New York.

Casting Brass and Bronze-II

Oxygen Burns Metals with Evolution of Heat—Those with the Higher Heats of Formation Act as Deoxidizers—Oxides Remaining in Alloys Cause Trouble—Metals Removed from Alloys by Oxidization

BY CHARLES VICKERS

WHEN combustible substances like coal or wood are oxidized, the more familiar word *burned* is applied to the reaction, and this latter word has become associated with such visible phenomena as flames and glowing bodies that emit heat, and as the reaction proceeds the substance disappears except a few remains, entirely different to the original substance, called ashes. The substance that was burned has reverted largely to a gas which has escaped into the atmosphere as smoke, while heat and light have been given off during the continuance of the burning, which phenomena is popularly regarded as an act of destruction because the substance itself has vanished.

Similarly when a metal is entirely burned, or oxidized, it vanishes and in its place an ash is left which bears no resemblance to the metal oxidized. But if the ash is weighed it will be found there is more of it than there was of the original metal, whereas in the case of coal or wood, the ash is only a small percentage of the weight of the original substance. Because of this difference it is difficult for some persons to understand how a metal can be burned, and their attitude becomes one of scepticism towards this change. When any substance, whether wood, coal or metal is oxidized, it is burned, but it is more proper to apply the word burning or combustion, only to such substances which while being oxidized give out light and heat. While metals do both, it is not observable so readily in a brass melting furnace.

Metal Oxidized

When any metal unites with oxygen it is said to be oxidized, and the resulting compound is an oxide. The change is one of chemical combination and such combinations are attended with the evolution of heat and sometimes light also. The heat given off is known as the heat of formation of that particular oxide, the amount of heat given off being estimated in heat units or calories. A certain weight of water is taken and the quantity of heat required to raise its temperature, from 0 to 1 degree Cent., is the heat unit. When the weight of water is taken at 1 gram, the unit, called a calorie, is small, and the figures obtained in calculations are large. For this reason 1 kilogram (2.2046 pounds) of water is most usually taken, and the quantity of heat that will raise this amount of water from 0 to 1 degree Cent., is called a kilogram calorie. The quantity of heat thus disengaged by a metal in forming a chemical combination may be considered a measure of the chemical affinity of that metal, and as a consequence by referring to tables of the heat of formation of metals it can be ascertained what metals will act as deoxidizers of other metals.

All the usual metals found in brass foundries oxidize, and the heat of formation of their oxides has been determined. Some of these metals form one oxide only, others form a number of oxides. Thus there are two oxides of copper, one consisting of two atoms of copper combined with one atom of oxygen, and another containing one atom each of copper and oxygen. The first oxide is known as cuprous oxide. It is ruby red in color and its heat of formation is 42.3 kiligrom calories. The second oxide, known as cupric oxide, is black in color, and its heat of formation is 37.2 kilogram calories. As this figure is less than that of cuprous oxide it indicates that if it should be added to molten copper containing cuprous oxide it would be reduced by the latter, or, as in this case both are oxides of the same metal, the free copper would split off one atom of the oxygen held by the cupric oxide and form additional cuprous oxide. From the superior heat of formation of cuprous oxide we can assume there will be only the one oxide present in copper; the cuprous oxide. This assumption appears to be in accordance with the facts in the case. Thus for any other metal to be able to deoxidize copper, its oxide must have a greater heat of formation than cuprous oxide. Usually when the heats of formation of two oxides are similar, with only a slight difference between them, little if any substitution of the one oxide for the other will take place.

Lead, like copper, has two oxides; one with one atom each of lead and oxygen, and the other with one atom of lead to two atoms of oxygen. These are known respectively as lead oxide and lead peroxide, more familiarly as litharge and red lead; the latter being regarded as a mixture of the two oxides which acounts for the formula usually given it of Pb_3O_4. The heat of formation of lead oxide is 50.2 kilogram calories, or 7.9 calories greater than cuprous oxide. It is not likely, therefore, that lead will deoxidize copper, as the heats of formation of cuprous oxide and lead oxide are too close together.

Tin Deoxidizes Copper

Tin also has two oxides; one having one atom each of tin and oxygen and known as stannous oxide and the other having one atom of tin and two atoms of oxygen and known as stannic oxide. This last oxide is the principal mineral of tin and is known as cassiterite or tinstone. The heat of formation of stannous oxide is 66.9 kilogram calories, and that of stannic oxide 137.5 calories. The latter oxide is the one that would be formed in copper alloys, and as its heat of formation is 95.2 calories in excess of that of cuprous oxide, it is evident that tin will deoxidize copper; that is, when tin is added to copper containing cuprous oxide, it will seize the oxygen held by the copper and thus substitute tin oxide for copper oxide in the alloy.

Zinc forms only one oxide which contains one atom each of zinc and oxygen; its heat of formation is 85.2 kilogram calories. Zinc, therefore, will deoxidize copper, but it will find tin a difficult proposition to deoxidize; in the case of the tin existing as stannous oxide as the heat of formation of zinc oxide is only 18.3 calories higher, it is doubtful if any action in the way of substitution of zinc for stannous oxide would occur. As the heat of formation of stannic oxide is 52.3 calories in excess of

that of zinc oxide, tin would deoxidize zinc.

Aluminum normally forms only one oxide. It is known as alumina and contains two atoms of aluminum to three atoms of oxygen. Its heat of formation is 380 kilogram calories. This is so largely in excess of the heats of formation of the metals just discussed that there is no question of the power to aluminum to remove their oxides. In fact, it is too powerful to use as a deoxidizer, and that is the reason it causes so much trouble when mixed with other metals it is too greedy for oxygen.

Silicon forms only one oxide known as silica, and the greater part of all sands is silica. Its heat of formation is 191 kilogram calories, therefore it is an efficient deoxidizer of copper, but like aluminum it is not safe to use it in alloys, especially those containing lead, as it forms nonmetallic bodies called silicates with great facility. Phosphorus also is an efficient deoxidizer; the heat of formation of its highest oxide is 370 kilogram calories.

Manganese forms a number of oxides. Two of them are MnO and MnO_2, the latter is known as black oxide of manganese, or manganese dioxide. The heat of formation of MnO is 90.8 kilogram calories, that of MnO_2 is 123 calories. Another oxide is Mn_3O_4, which has a heat of formation of 325 kilogram calories. Manganese is, therefore, a very efficient deoxidizer and has power to remove oxygen or to substitute its own oxide for those of copper, tin, lead and zinc.

Judging by the heats of formation of their oxides, all the metals used in making alloys of brass and bronze, with the exception of lead, are able to deoxidize copper. Lead also would deoxidize it, provided the conditions were such that the higher oxides of lead were formed, as these have a higher heat of formation than litharge. Both tin and zinc oxides are highly infusible and are likely to remain in the body of the alloy as nonmetallic bodies; in fact, such oxides are found in bronze.

Oxide Is Reduced

The effect of infusible oxides within the body of an alloy can be illustrated by aluminum bronze. When aluminum is added to molten copper, the oxide dissolved within the latter is reduced and alumina is formed. This only is eliminated slowly and is thus liable to remain mixed with the metal. In an experiment made by the writer, a massive, solid cylindrical casting of aluminum bronze (the 10 per cent alloy) which had been permitted to cool naturally, and therefore slowly, in a sand mold, was heated to a bright red, at which temperature the cement between the crystals is loosened. A sledge hammer was applied with the result the skin of the casting ruptured like a paper bag, and the crystals individually and in aggregations came tumbling out like peas from a pod. Some of the larger crystals were found to be deeply pitted by oxide grains which had bitten into them. These oxide inclusions, instead of being detached and scattered, were mainly in groups with a decided tendency to spread out in thin layers. In the case of one clump of crystals the oxide masses extended ¾-inch, making a continuous and deep channel through the crystals. It is because of this it is so difficult to make castings containing aluminum that will withstand pressures; some oxidation of the aluminum is inevitable, and the oxide strings along at places within the castings favoring its deposit, and affords an easy exit for gases and liquids under pressure.

While aluminum acts much worse than tin, zinc or lead in this respect, the tin and zinc are not free of blame, as the difficulties encountered in making pressure resisting castings show. When the oxide of copper is exchanged for that of tin or of zinc, there is a limit to the amount of substitution that can take place within the alloy, and make possible a gratifying percentage of satisfactory castings. It is a matter of the utmost importance when making such castings that the production of cuprous oxide be held down to the lowest possible limit by taking precautions in melting the copper, for while tin oxide and zinc oxide may act somewhat differently to alumina in respect to segregating in layers, the oxide particles will have a strong tendency to coalesce, which will be certain to produce a high percentage of leaky castings. From these remarks the importance of a careful selection of the stock metals, together with careful and intelligent melting in the elimination of the difficulty of leaks, can be judged.

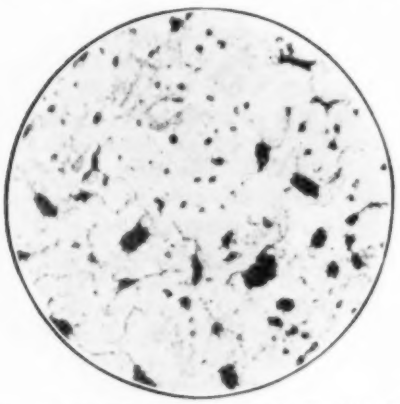


FIG. 1—LEADED BRONZE CONTAINING OXIDE—ETCHED WITH FERRIC CHLORIDE—× 100 DIA.

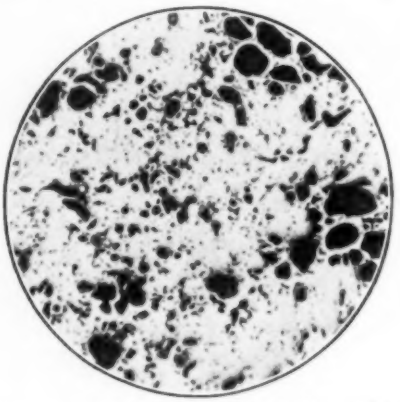


FIG. 2—ALLOY CONTAINING ONLY SMALL AMOUNT OF LEAD—ETCHED—× 20 DIA.

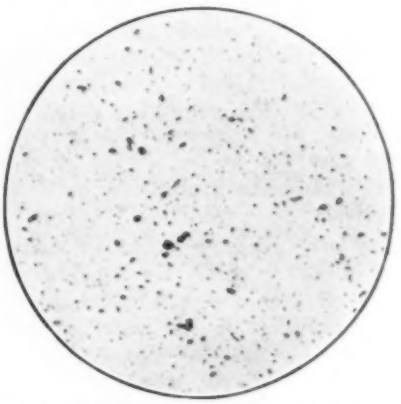


FIG. 3—HIGHLY LEADED ALLOY SHOWING SEGREGATION OF LEAD—UNETCHED—× 20 DIA.

It is the oxides formed within the metal that figure so largely in producing castings that fail under pressure. Other factors enter the equation and operate to produce a similar result in a much more restricted sense. It safely can be assumed that three parts of the battle to get pressure-tight castings has been won when metal that is *clean* has been produced by the furnaces. The remaining part of the battle centers around proper pouring temperatures; well-considered gating methods; provision against shrinkage, including the seeping of eutectic from the higher to the lower parts of the casting. To prevent such seepage, the design of pattern to avoid abrupt changes of metal thickness is a great help.

When high grade castings that are expected to meet specifications for physical properties are to be made, a deoxidizer should be melted with the copper, for which service phos-

phorus is especially useful. Then the white metals are added. In this manner the formation of other and more infusible oxides is prevented, or reduced to a minimum. As oxides have been removed from the copper bath, or have been exchanged for one that cannot be reduced by the metals to be added, the question may be asked which of the alloying metals should be added first? As the oxide of tin is hard, infusible and difficult to reduce, no chances should be taken with its formation within the metal. Therefore, the tin should not be the first metal to be added, provided other metals also are present. Either the lead or the zinc addition can be made. Usually it is the zinc although there are melters who habitually add the lead first. If the lead would deoxidize the copper, and no other deoxidizer had been added, it would be the logical metal to add first as its oxide melts at 1650 degrees Fahr., and also is volatile at that temperature so that part of it would be removed by evaporation; even though its high specific gravity would oppose its rising to the surface of the alloy. In the case of alloys containing as high as 50 per cent lead, any lead oxide formed floats easily and is always found on the tops of solidified sprues as a glassy, yellowish slag; in fact, the presence of this slag is a sure sign that the lead has not *segregated* in the castings from that particular heat, and for good reasons.

Order Unimportant

The order in which the white metal additions are to be made to a copper, carefully melted and deoxidized, is unimportant, except that tin because of the irreductability and infusibility of its oxide should be added last. As regards zinc, its oxide is volatile when produced by the oxidation of distilled zinc; but in alloys, if formed therein, it has a decided tendency to remain submerged. Thus, if copper is melted and badly oxidized and then zinc is added to form brass, the result is a *thick* metal that will not flow. Every brass founder knows that. This is because the zinc oxide has remained in suspension in the brass, and its effect is as bad or worse than that of cuprous oxide. Evidently such a metal would produce leaky castings and the difficulty of producing castings from yellow brass that will hold pressures is one proof of the fact that the oxide of zinc is not easily eliminated from brass. Owing to this property of zinc it makes no difference what name is given to the yellow brass; thus, it may be called manganese bronze, but if the zinc is added before the copper is deoxidized, the highest qualities of the alloy will fail to materialize.

Much of the trouble zinc causes in brass foundry operations is due to its comparatively low distillation point. It boils at 1685 degrees Fahr., and emerges from the bath of metal as zinc vapor; that is, it is distilled out by the heat, and instantaneously is caught by any oxygen present with the formation of zinc oxide, which is the substance of which the smoke screen thrown out by yellow brass is composed. This zinc oxide smoke when breathed may produce the illness known as spelter shakes, and is a nuisance generally in shops where yellow brass is cast. It should be

FIG. 4—GRAINS OF MOLDING SAND EMBEDDED IN HIGHLY LEADED ALLOY—UNETCHED—× 200 DIA.

kept out of the lungs. An easy manner of doing this is to tie a folded handkerchief over the nose and mouth. However, the old fashioned yellow brass molder would laugh at such precautions.

When zinc is oxidized by the temperature of the furnace, as it is a light flocculent substance it passes away as smoke. This sometimes condenses and forms flakes, and when the distillation is proceeding actively an intense bluish light is also given off. When this occurs it is evident the zinc is burning like wood or coal, and that if the reaction was allowed to proceed long enough, all the zinc would be lost, having vanished as smoke and zinc flakes. When such a phenomenon is witnessed it is not so difficult to believe that metals can burn, for zinc is a metal and is evidently burning, as light, heat and smoke are all given out, and the zinc seems to be destroyed. The illustration, Fig. 1, shows the appearance of oxides within an alloy. The black spots are lead, but the curved, dark lines are the oxides. They appear as yellow spots in the fracture of the alloy.

Being earthy in character they are permeable to gases and their presence causes castings to leak. As shown in Fig. 1, the lead also segregates, the spots being lead, but as lead is a metal it is impermeable to gases and liquids. Fig. 3 is the micrograph of a highly leaded alloy. The black areas are lead. In Fig. 2 the alloy contains only a small amount of lead —0.5 per cent. It is scattered throughout the alloy in finely divided particles. The presence of some lead is desirable in alloys for pressure castings, as it acts to render them tight. It does this by flowing into any openings that have formed in the alloy, thus filling and sealing them. In Fig. 3 it is probable that some of the larger pools of lead are filling what would be vacant places, but for their presence.

Shows Sand in Metal

The micrograph, Fig. 4, shows how sand can get entangled in leaded alloys. The magnification is 200 diameters. The black spots in the white background are lead. In the large black mass in the center of the illustration, are shown three sand grains and some broken grains, and part of the black section is a cavity. The alloy contained 32 per cent lead, and the sand was incorporated by melting sprues and gates encrusted with burned sand. The sand was held in suspension until the metal solidified, just as though it was one of the oxides we have been considering.

Sand, of course, is oxide of silicon. While it is known to make *sand holes* in castings of bronze it is not usually found incorporated within the alloy. It will cause difficulty though in the case of highly leaded bearing alloys when it is permitted to mix with the metal, and the difficulty is exactly as shown by the micrograph, Fig. 4.

In the case of the leaded alloy it is probable that some lead oxide was present and by filming the sand grains aided in their retention in the alloy. It was a difficulty caused by carelessness for which there was no excuse, but it proved a problem impossible for the foundry to solve themselves, and caused the loss of much money. The alloy was used successfully for bearings in gas engines for a year or more, then suddenly it became impossible to produce a bearing

that would not score the shafts. Engines were shipped to remote parts, and trouble followed. Then men had to be sent to remove the bearings and to replace them. In machining the defective castings it was noted there was some powdery substance present that dulled the tools quickly, but if anyone had suggested that it was sand, the suggestion would have been scouted until the metallographist proved conclusively that sand was present. After that no sand encrusted sprues were melted, and more attention was given to guard against oxidation in melting the copper, and the difficulty ceased as abruptly as it began. For after the cause was discovered it could be guarded against in the future.

It has been shown that when a metal or alloy is deoxidized all that is done is to substitute one oxide for another, which substitution may or may not be of advantage, depending upon whether the substituted oxide easily detaches itself from the fluid alloy, or not. For one metal to deoxidize another it must possess a greater affinity for oxygen, which property can be predicted from a study of the heats of formation of the respective oxides. It is also possible to reverse the operation; instead of deoxidizing a metal we can oxidize it, either by adding some metallic oxide to the molten alloy, or by using atmospheric oxygen. The latter method is the cheaper and the one adopted in refining most metals on a commercial scale. Cast iron is converted into steel by an oxidizing process, using a peculiarly-shaped vessel known as a converter into which the molten cast iron is poured, and then air is blown either through the liquid metal from the bottom of the vessel or from the side so as to impinge against the surface of the iron at such an angle that it digs into it. The air burns the silicon carbon and other impurities from the cast iron then deoxidizers and other additions are made that change it into the steel wanted.

Copper also is partly purified in converters, and in refining it the impurities are oxidized by blowing compressed air into the molten bath. It is rarely that in brass foundry operations the necessity for such oxidizing methods arises that would call for the use of air, but occasionally it becomes desirable to replace one metal in an alloy by another. Thus suppose that an alloy contains an excess of zinc and a deficiency of lead. This can be remedied by treating it with lead oxide, or litharge, when the zinc alloyed with the copper will take the oxygen from the litharge, leaving the lead which sinks into the fluid metal; thus replacing the zinc by lead, according to the equation:

$$PbO + Zn = Pb + ZnO$$

To remove 3 pounds of zinc would require 7 pounds of litharge and in exchange for the zinc, nearly 6½ pounds of lead would be added to the alloy. In this manner small amounts of zinc can be removed from alloys in which its presence may be considered objectionable. Aluminum also can be removed from certain alloys in a similar manner, but instead of lead oxide, copper oxide can be used as the oxidizer. This oxide also can be used to remove zinc from an alloy, replacing the zinc in the alloy by copper.

To remove the aluminum from 100 pounds of the 10 per cent aluminum bronze, will require close to 80 pounds of copper oxide, as determined by numerous experiments, and of course the copper contained in the oxide is recovered, but the 10 pounds of aluminum are lost, therefore, this method of refining metals is too costly to be practiced generally on a commercial scale.

One of the problems now confronting both brass founders and makers of ingot metals is to remove small amounts of aluminum from commercial alloys without at the same time removing the other metals alloyed with the copper. It is possible to accomplish this quite easily in the case of such metals as phosphor bronze, by melting it with copper oxide, but the content of aluminum must not be greater than a few tenths. This in one case phosphor bronze turnings were found to be always contaminated with chips of aluminum bronze. The chips were mixed thoroughly and analyzed, and based on the analysis of the aluminum content, copper oxide was added and a small melt made to determine the result. Then the entire shipments of the chips were melted and cleaned in this manner. Neither lead nor copper oxides can be used to refine aluminum from copper-zinc alloys, as the zinc and aluminum are removed together, and as long as any zinc remains in the alloy there also will be aluminum. Eventually, if additions of oxide are continually made to the molten alloys, all the zinc and aluminum are removed and only copper is left. Thus to remove the aluminum from old manganese bronze and permit it to be used as yellow brass, the addition of copper oxide to clean it would result in the loss of probably 40 per cent of the metal treated. The removal of aluminum from yellow brass leaving both copper and zinc behind, can be accomplished, but it is necessary to use an oxidizing substance much stronger than zinc, but weaker than aluminum, in its affinity for oxygen, and in addition, it must be cheap.

How and Why in Brass Founding

By Charles Vickers

Finds Hard Spots in Brass Castings

Upon machining our brass castings we find little hard spots under the skin and the tools will not stand up. We are running cast iron, brass and aluminum in our foundry, but the cast iron is kept separate, and the brass and aluminum molds are made in sand confined to their use. One of our customers claims that we cannot run brass successfully in the same shop where aluminum is cast. What effect has aluminum on brass? We use scrap such as old valves and bearings in our brass castings and sometimes find a little steel such as rivets or screws, or even nickle silver, but would the latter harden brass? We melt the brass in a pit furnace and the aluminum always is melted in an oil-fired furnace.

The cause of the hard spots is iron or steel and it is important to have the scrap looked over for pieces of iron or steel, which should be carefully removed. If brass chips are used the iron must be removed by magnet or by magnet machine. The trouble caused by iron all hinges on the fact that while iron and copper do form alloys there is no

strong affinity between them and unless pure they will not mix. Thus, cast iron and copper or bronze will not alloy but separate into layers, and the cause of this separation is the fact the iron is already alloyed with carbon, something the copper will not tolerate, but the iron holds on to the carbon so strongly the copper has to reject both of them and the melted iron carbon mixture, which is steel separates and becomes scattered thoroughout the brass as it solidifies. These little pieces of iron are extremely hard because the iron takes up other impurities as well as the carbon. Should there be manganese present it will combine with that and together with the carbon form manganese steel. In the absence of manganese, there is tin which alloys with the iron and carbon to form an extremely hard compound which the copper has no power to assimilate. These little specks being harder than the steel tools destroy the latter and for that reason iron must be kept out of the brass.

While iron and tin form alloys quite readily, and copper and tin also alloy, the presence of tin in the alloy will not insure the iron and copper uniting because the tin has no power to separate the carbon from the iron, and it is the carbon that forms the stumbling block to the union.

Aluminum on the contrary has the power to remove the carbon from iron, and if cast iron and copper are melted together and aluminum is added out will come the carbon and the copper and the iron and aluminum combine to form an alloy. This is the reason that aluminum bronze may contain iron and still be machineable. Silicon, which greatly resembles aluminum in its effect on nonferrous alloys, also causes the iron to combine with the copper, although it acts differently to aluminum, in that copper iron and silicon may be mixed, and the iron will separate as particles that will rust, but they will be soft and machineable. In other cases the iron may be thoroughly alloyed with the copper and silicon. Therefore, keep iron away from red and yellow metal, and there will be no trouble from hard spots.

It is also advisable to carry several per cent of lead in the brass. Thus a red brass will carry 5 per cent lead easily which helps the machining qualities. Pay no attention to those who say that aluminum and brass cannot be run in the same foundry, as there are few brass foundries in the country who do not also make aluminum castings on occasion. But be just as careful to keep the aluminum out of the brass as the iron, for while the aluminum will not make hard spots; in fact it would soften the ones that are there, still it is harmful because it causes the castings to run drossy, and also gives them a dirty whitish sheen on the surface. The presence of a small amount of aluminum will show on the surface of the castings, as they will be whitish and will have dirt spots. If the castings come clean and of the natural color of brass castings, no aluminum is getting into the metal. All that is necessary is to skim the aluminum on a separate floor and to keep the sweepings separate.

Plaster Molds Difficult

We have a certain part of our machines to cast of brass which requires a smooth surface, although not as smooth as a milling cut. We understand that it is possible to get a smooth surface by using plaster of Paris instead of sand, and we would greatly appreciate your advice as to whether this is practical, and if so what method we should follow in using the plaster?

It is not practical to make brass castings in plaster of Paris molds in an ordinary brass foundry because the methods required differ greatly from the sand mold methods, and also require special knowledge and apparatus. Thousands of dollars would have to be spent to learn how to make castings by this method, and then the castings would cost more than if they had been purchased from those who specialize in such work. Such castings can be obtained, either die cast in aluminum bronze to accurate limits of measurement, and of smooth surface; or they can be obtained by the plaster of Paris method from an alloy resembling manganese bronze.

It is advisable to purchase these castings and particulars can be obtained from any of the concerns mentioned in the letter we are addressing you.

Drums Offer Difficulties

We are casting large drums from a 60-40 *mixture of lead and copper, but experience difficulty as the castings are porous at the upper part. These drums are around* 20 *inches in diameter and from* 20 *to* 30 *inches in height with about* 1 *inch of metal in the walls. The bottom of the castings runs sound and perfect, and similar castings, but only* 12 *inches in height give no trouble as they are always perfect, both at the top and bottom. We would like to have your version of the reason these castings run this way. We gate them on the bottom and take a large riser off the top. Would it be caused by the lead segregating, or due to moisture present because of insufficient skin drying?*

I have heard it stated time and again by exceedingly confident people that there is no such word as impossible in any language, but in the light of many years of experience in the casting of brass, bronze, aluminum, iron and steel, I personally prefer to qualify such a statement by saying, that nothing may be impossible after we have gained the knowledge necessary to success. However, under present circumstances, many things are impossible. In the case of these castings, we are confronted by the fact that up to 12 inches in height, they run perfectly, but above this limit they are permeated with holes. Therefore, with our present kuowledge of the subject, it is not possible to run the castings up to 20 or 30 inches with the same results as obtained with the 12-inch castings, and we are ignorant of the causes underlying this fact.

This suggests the idea that if we can run 12 inches perfectly and want to put on another 12 inches, that it would be a good plan when we arrive at the second 12 inches to make a fresh start, that is, start with one ladle or pot of metal and pour 12 inches of the casting as determined by watching down a small riser placed for the purpose, then start another pour from a fresh pot, just as hot as the first one was, but pour this metal down its own sprue and through gates placed at the 12-inch limit just as though starting to pour a second casting. Whether the two pots can be relied upon to pour only 24 inches, or whether they will carry up to 30 inches, can only be determined by experiment. And the rate at which the second portion is to be poured also, can be determined only by experiment. On the face of conditions one would imagine the second section should be poured much slower than the first to give the latter a chance to congeal at the bottom and take metal to feed its shrinkage while plenty was available.

To account for the phenomenon of the smaller castings being good and the larger unsound, many ingenious reasons could be evolved, some near-fetched and others far-fetched. We could discourse learnedly about the sulphur which is probably put in to *hold in the lead* and mention how it MIGHT BE that in pouring from the same metal supply when the pouring had proceeded to the 12-inch limit, a sufficient amount of oxygen had been absorbed to react with the sulphur present, and by producing sulphur dioxide, account for the gas cavities present. Then we could blame the lead for *segregating* conveniently shutting our eyes to the fact that if it did, the bottom of the casting would be lead. We believe a good way to side step the trouble will be to proceed as outlined, thus taking pattern from the method adopted in casting certain shapes of copper in chill molds, in which the mold is poured in steps, section after section being filled as though building a wall.

Electrical Oven Bakes Enamel

Rochester Foundry Utilizes Electric Heat, Pyrometer Controlled, for Baking Enamel on Stove Castings—Close Temperature Regulation Is Obtained

BY EDWARD W. ROESER

FOR a great many years the application of vitreous enamel to steel and iron products has been accomplished through the agency of fuel fired furnaces; using coke, coal, oil or gas as a heating medium. The practice required in this art until recently was regarded as quite secret, due largely to the operator's familiarity with the system of temperature control devised by himself from experience.

Electric heating for many years has been regarded as too expensive and until recently little experience had been accumulated concerning the uses to which nickel-chromium wire could be subjected. Like any new departure from accustomed practice, the use of electric heat for high temperature work met with criticisms. Excessive cost, the failure of the heating elements, and their destruction due to impurities which might come in contact with them when at high temperature, were among those most frequently mentioned.

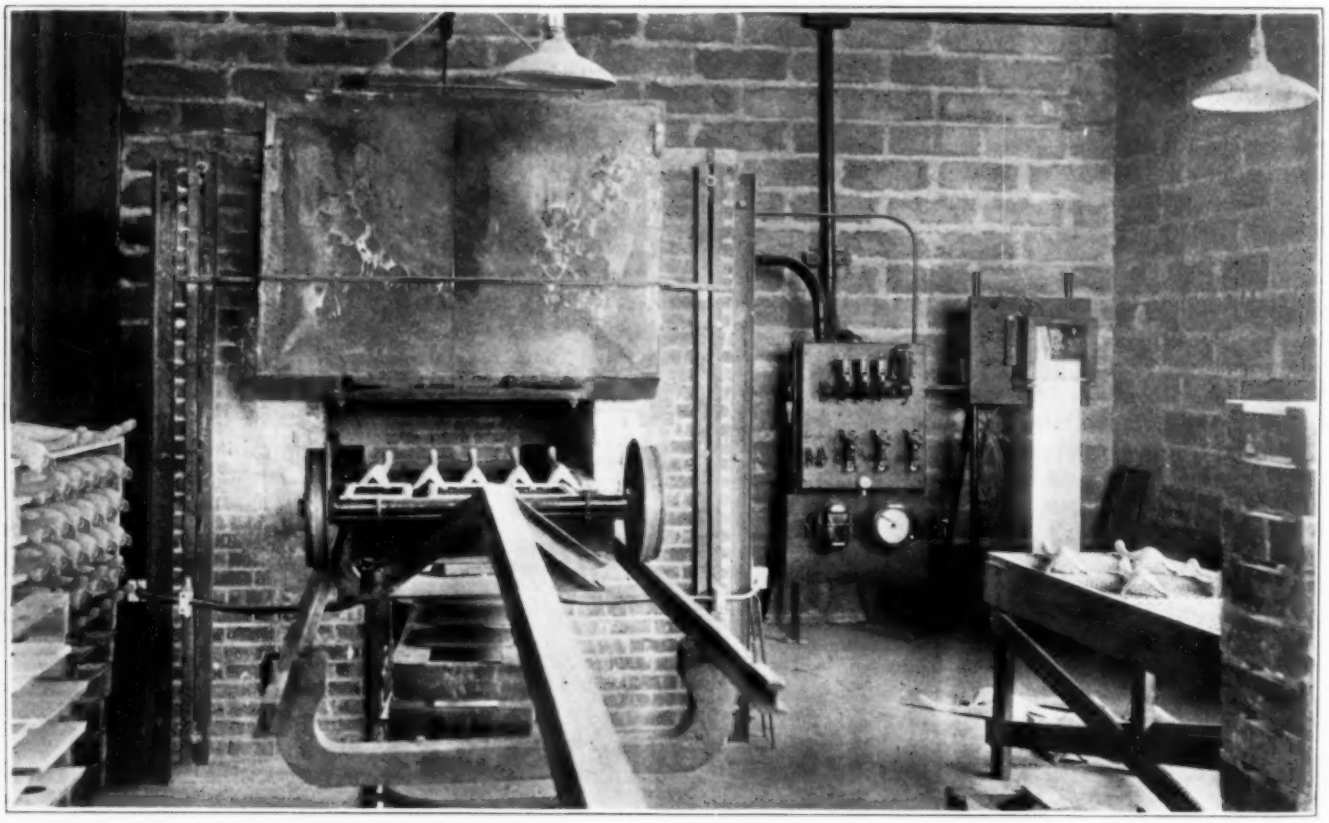
The author, Edward W. Roeser, is engineer for the Rochester Gas & Electric Corp., Rochester, N. Y.

The cost in inconvenience and lack of control when having enameled work done in other plants caused the Galusha Stove Co., Rochester, N. Y., to consider installing an enameling plant of their own. Coke, coal and oil-fired furnaces received careful consideration, but the difficulty of securing accurate and comparable information caused some confusion as to the actual merits of each except in a general way. From prescribed performance data, the cost of operation of an electric furnace was estimated. The installation cost together with the inherent advantages of electric operation were factors that determined the selection of an electrically heated installation.

Construction Is Simple

The Galusha furnace consists of a lower and upper rectangular chamber the side walls of each carrying refractory supporting bricks upon which nichrome ribbon is suspended. The space occupied by the heaters is in a sidewall niche so as to avoid contact with incoming work. A winding has been placed on the front wall of the lower chamber to provide compensation for door losses. On each side wall in the lower chamber one third of the capacity is distributed as a double winding. The remaining third is distributed on the side walls of the upper chamber as a single winding excepting near the charging door the winding is doubled to assist the front lower chamber single winding in compensating for door losses. Such a disposition of heating elements enables the operator to utilize the entire depth of the furnace and further contributes to the distribution of a uniform heat throughout the working space.

The windings are rectangular cross section and are suspended on suitable refractory brick on the side walls of the furnace. The ends are bent and drilled for terminal connection and additional



CASTINGS ARE PLACED ON A TRAY WHICH IS HANDLED BY A FORM SUPPORT, AND RUNNING UPON WHEELS ALONG THE TWO RAILS SHOWN

nichrome wire is welded to the terminal strip which passes through a wall bushing and is secured in place by a set screw in a collar washer.

The products to be enameled are placed on thermoalloy triangular bars which rest on the arms of the charging fork shown in the illustration. When charging the furnace, the load is advanced in the chamber and the bars are lowered onto the projecting refractory ledge which separates the lower and upper chambers. The charging fork is then withdrawn, the door closed and the work subjected to the radiant heat of the element for the firing period. In unloading the above operations are reversed in sequence. That the external radiation losses may not be too great, air cell insulating brick 12 inches thick surrounds the heating chamber. Such brick has little mechanical strength and is therefore re-enforced by an outside wall made up of one course of red brick. The windings are connected in delt and this network is supplied with power from the consumers service at 23 volts, 3-phase, and 60 cycle through the contactors shown at the top of the switchboard. The control switch energizes the contactor magnet closing the circuit. At the bottom of the board three relays are located. The one at the left controls the energy supply as dictated by the Leeds-Northrup, Philadelphia, temperature control, and the other two provide protection against overloads. The Leeds-Northrup control receives a voltage from the thermocouple inserted in the rear of the furnace chamber. This voltage creates an unbalanced condition in the galvanometer system proportional to the temperature. The galvanometer control element through the mechanical train devised, indicate the temperature in the chamber. A dial in the rear of the instrument is so operated that when the temperature is low the closing relay at the left closes the contactors at the top of the board. When the temperature exceeds the predetermined value the opening relay, which is combined with the closing relay, operates to disconnect the contactors from the circuit. By this arrangement the temperature may be controlled within the narrow range of 5 degrees Fahr.

Such accurate control makes it possible to duplicate results in such a furnace whereas some difficulty is experienced in this connection in other types. It also contributes to the economy of operation which is important when employing electric energy as a heating medium, in that the automatic control limits the power consumption to the actual producton requirements of the furnace.

Furnaces now are designed which will produce 6.5 to 7 pounds of metal enameled per kilowatt hour at a temperature of approximately 1600 degrees Fahr. An efficiency of this character is indeed inviting when electric energy can be purchased at low cost. Some furnaces have been installed where the rate per kilowatt hour is as high as 2.5 cents. Lower rates than this are possible locally, the actual rate being dependent on the manner of use in accordance with provisions in the rate schedule. The furnace under consideration operates after the foundry load is off and in addition, during the winter months, remains off from 4 to 7 p.m., thereby earning a favorable rate.

When the foundry closes down the control switch is thrown in and the temperature allowed to attain its working value whereupon the control equipment disconnects the energy supply. After the furnace has been thoroughly dried out and then allowed to cool with the door open and having a temperature inside of less than 200 degrees so that a man may work in the chamber, it takes approximately four hours to attain a temperature of 1300 degrees Fahr. Normally, if the plant is shut down in the afternoon at four or five o'clock and current is turned on to the furnace in the morning ta seven o'clock, about 45 minutes are required to raise the temperature from 900 degrees to 1300 degrees Fahr. I merely cite these two instances since they represent general practice at the Galusha Stove Co., depending upon the time of year. An electric load of this type is particularly desirable for several reasons, first it generally uses energy 24 hours per day, and when properly operated a load factor as high as 80 per cent may be obtained; second it does not require any more capacity from the central station than its connected load; in other words it is a noninducive load and therefore operates at unity power factor. This is a vital consideration in central station equipment investment. Cast iron products are sand blasted and then cleaned by compressed air after which enamel is sprayed on them. They are then dried and fired. The temperature at which the castings are fired largely depends upon the constituent parts of the enamel used but with cast iron, temperatures from 1200 degrees to 1400 degrees Fahr. are employed. The finish is hard and glossy being made up in a variety of colors such as white, gray, blue and black.

Steel for enameling is used in sheets and is treated in an acid bath before the enamel is applied. The enamel is flowed on the work and allowed to drip before being placed on the rack to dry. The firing is conducted in the same manner as with cast iron with the exception that the firing period is but 2 or 3 minutes and the temperature higher, somewhere around 1600 degrees Fahr.

Both recent developments and experience clearly indicate the wide application of electric heat for industrial processes. The cost of electricity as normally used has established an unwarranted fear in the minds of many that its use would be suicidal for furnace operation whereas it can be utilized to advantage in most heating operations at a cost justifying its use in competition with other fuels. It cannot be used economically unless careful technical judgment is brought to bear in design of equipment and operating knowledge to use the rate schedule to the best advantage is acquired by responsible employes.

Two years ago the Galusha Stove Co.'s electric enameling furnace was the second furnace in operation on a commercial scale in this country; today over 30 furnaces employing similar temperatures are in daily operation and their number is being added to at a phenomenal rate. That the furnace is giving satisfaction is more clearly emphasized by saying that plans are now under way for the installation of an additional unit, having a capacity of 95 kilowatt. This new unit will be operated 24 hours per day to obtain the advantage of a lower rate schedule.

Another plant having had experience of 1½ years with six electric furnaces has completed its plans for the installation of six additional furnaces each having a rated capacity of 60 kilowatt.

Planning Production on Limited Orders

BY JOHN GRENNAN

SPECIALLY constructed flasks, molding machine mounts, core plates, core dryers, coreboxes and patterns all are designed to reduce costs to a minimum in the production of automobile castings and castings for standardized machines of any description. The use of molding machines and special rigging usually is limited to castings to be made in fairly large quantities and where future orders are expected. Where only a few castings are ordered and where future orders of the same type and kind are not expected, little thought, planning or preparation is devoted to the subject. The drawings are sent to the pattern shop where a pattern and if necessary, a corebox, are prepared and delivered to the foundry. The cores are made by hand and dried on any convenient plates available in the core room. The flask carrier takes the pattern into the yard and finds a flask in which the job may be made. The molder is free to make any necessary adjustments in the flask and bars and to follow his own judgment in making the mold. The foregoing method frequently is employed where a little planning would reduce the cost of production even though only a few castings were ordered and no future calls were anticipated.

The policy pursued at the University of Michigan, Ann Arbor, Mich. is to make use of the molding machine equipment for instructional purposes. A demand exists at the university for more castings than the students can produce in the foundry course and therefore plenty of work is available, but frequent changing of molding machine equipment is required.

An order was received for 15 tons of castings to be made from six different patterns. The castings were to form part of the equipment for a new building and there was no prospect of a repeat order. The drawings were turned over to the foundry students with instructions to plan rigging and methods for turning out the castings under the most favorable conditions. Foundry appropriation funds were low at the time and it was necessary either to use equipment on hand or to limit new equipment to what could be made in the shops. Under a time delivery clause in the contract, the entire lot of castings had to be made in 20 heats. The students worked out the methods by which all the patterns with one exception were mounted on machines. In every case the results justified the belief that even on such a comparatively small tonnage, 15 tons made from six different patterns, the time and equipment required to plan an dmount the patterns was a profitable investment. The method adopted in the case of one pattern shown in the accompanying illustration is interesting, indicating how available equipment and simple rigging were combined to increase production.

The order called for 450 stool pedestal castings, 20 inches long, 5-16-inch metal thickness and provided with a 6-inch square base at one end. To take advantage of a core plate of which 12 were in stock, a twin corebox was made as shown in Fig. 1. The jig and strike shown to the left Fig. 1 were employed to size and surface the half cores before they were pasted. The jig was made of wood reinforced with metal strips and the strike was made from a piece of flat steel bar,

FIG. 1—PASTE IS APPLIED TO THE CORES WITH A RUBBER BULB FIG. 2—A TEMPORARY DEVICE ATTACHED TO THE SQUEEZER HEAD SERVED TO DRAW THE PATTERNS

ground square and straight on the edge. Instead of the usual messy paste pot and worn out brush or stick, a molders bulb was equipped with a brass tube to handle the paste. The paste was prepared in the usual manner from material furnished by one of the foundry supply houses and the bulb was filled by expelling the air, dipping the tube in the paste and then releasing the pressure on the bulb. In the illustration Fig. 1, one bulb is shown lying on the joint of the core while a second is shown with the nozzle inserted in the paste pot.

The molds were made on a jar ram squeeze machine made by the Arcade Manufacturing Co., Freeport, Ill. Wood flasks with iron ends that fitted close to the patterns were employed, because the distance between the uprights of the machine, 31¾ inches, would not permit the use of the next available size provided with wood ends. Two patterns were mounted on a board as shown at the right Fig. 2. On account of the arrangement of the patterns it was necessary to provide two boards, one for the cope and one for the drag. The patterns were mounted easily, simply and accurately according to the method outlined by "Bill" in the March 1 issue of THE FOUNDRY.

The molding machine originally was not equipped with a pattern drawing device, but a temporary drawing attachment was added in the following manner. The squeezer head was removed and a flat steel bar 2 x ⅜-inch was bolted on the upper side by a single loose fitting bolt in the center so that it might be swung from side to side. The planing strips on the upper side of the squeezer head provided ample clearance between the upper surface of the head and the lower edge of the channels constituting the upper part of the molding machine. An L-shaped bolt was fastened to each end of the flat strap as shown at *E* Fig. 3. The vertical part of the bolt was threaded to receive two nuts, one above and one below the strap. The horizontal toe of the bolt was designed to engage a suitable steel strip *C* attached to the end of the batten on the pattern board. One end of the flat strap was made a little longer than the other as shown at *A*, Fig. 3, to serve as a handle when throwing the lifting hooks into engagement. At other times a small spiral spring (not shown) held the lifting device in the position shown in the dotted line. This precaution was observed to prevent the hooks inadvertently getting caught between the squeezing head and the battens on the pattern or bottom board.

A simple method for leveling the flask before drawing the pattern was practised by squeezing the flask after it was rolled over. A stike provided with a ⅜-inch gap extending almost the entire length and shown resting on the head of the molding machine Fig. 2 was employed for scraping away superfluous sand after the mold was jolt rammed. The bottom board was placed in position above this ⅜-inch projecting thickness of sand and the flask was rolled over and placed back under the squeezing head. The act of squeezing the mold automatically leveled head, pattern mount and flask. With the exception that the squeezer board was substituted for the bottom board in the case of the cope, the practice was the same for both halves of the mold. Before exhausting the air the drawing attachment was swung to the left to engage the pattern mount. The mold then was lowered away from the patterns. This particular job never was made by hand but in comparison with similar jobs made by hand at least double the production was secured.

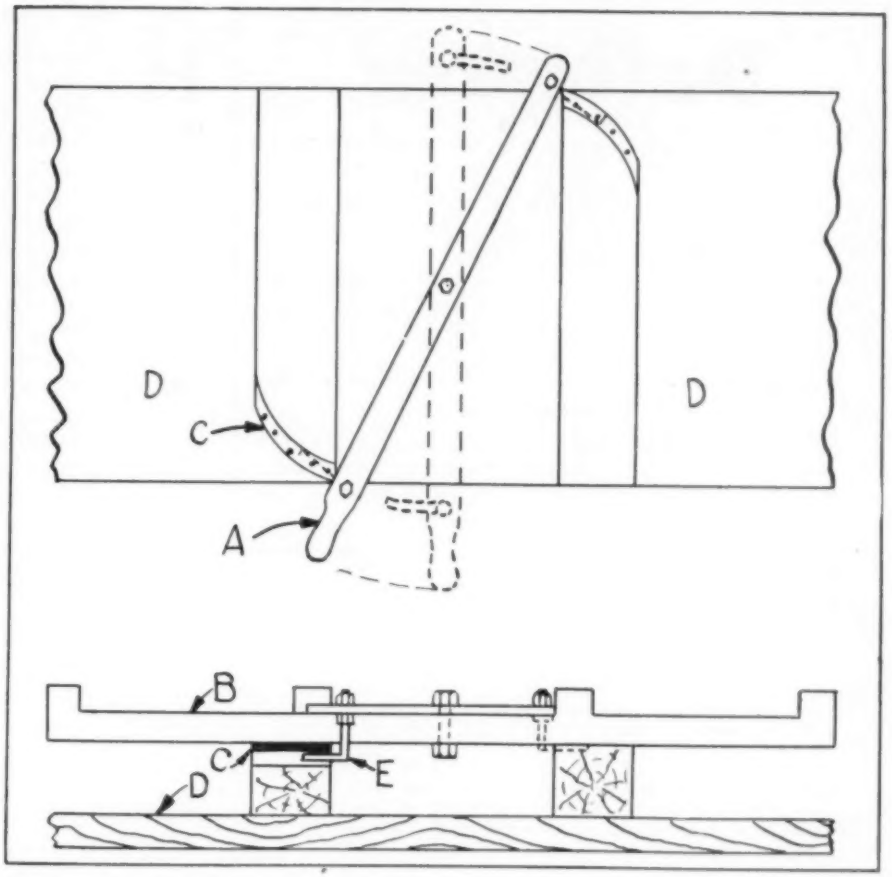


FIG. 3—IN THE LOWER ILLUSTRATION *B* REPRESENTS THE SQUEEZER HEAD, *C* IS THE STRAP FASTENED TO THE END OF PATTERN MOUNT BATTEN, *D* IS THE PATTERN BOARD AND *E* IS THE HOOK BOLT FOR DRAWING THE PATTERN—IN THE UPPER ILLUSTRATION, FOR THE SAKE OF CLEARNESS, THE SQUEEZER HEAD WHICH COMES BETWEEN THE STRAP AND THE PATTERN BOARD IS NOT SHOWN

The General Refractories Co. has opened a sales office at 200 Devonshire street, Boston. Malcolm C. Sargent is district manager and in charge of this office.

Re-equips Furnace Shop

The Monarch Engineering & Mfg. Co., 113 South street, Baltimore, recently has made important plant changes and has added new equipment to its plant at Curtis Bay, Md. The shop has been in operation many years, but the changes and revisions have been made necessary through demand for larger production. Previously, only about a third of the machine work was handled in the company's own shops, and the remainder was sent to jobbing shops. The completely equipped machine shop, recently added, makes it possible to handle all machining necessary. The remainder of the plant comprises a forge shop, assembling room, stock rooms, storage yards, galvanizing, sherardizing and tinning departments and the engineering offices of the company.

Starts Pattern Works

Albert J. Fox, formerly superintendent of the pattern department of the Buick Motor Car Co., and C. C. Wood have organized the Saginaw Pattern Works to make patterns for brass and aluminum castings. Mr. Wood formerly was connected with the Central Foundry of that city.

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When Nations Meet Again

HISTORY has a curious habit of repeating itself and although the repetition may not be exactly similar in every respect and in every little detail; although the periods of time between the events may vary, still in a broad general way the analogy holds to a certain extent as any person who cares to investigate for himself can verify. A few hundred years ago Scott's hero in the *Lady of the Lake* addressing his outlaw friend in nicely measured and metrical language assured him that twice he had visited Clan Alpine in peace, but warned him that when he came again he would come with banner, brand and bended bow.

Something over one hundred years ago the gallant Lafayette blithely sailed from his native France cheerfully placed his sword and his services at the disposal of a young nation fighting for its independence. It was not until a few years ago that the same nation now grown to lusty manhood had an opportunity to reciprocate. 'Tis true that on this occasion Uncle Sam entered France as a friend, but he came in all the pride and pomp and panoply of war and he brought with him unlimited quantities of the modern equivalent of banner and brand and bended bow.

A debt is a debt and a visit is a visit and human nature backed by countless centuries of custom and tradition decrees that each shall be paid. It is only fit and proper that each shall be paid in a manner worthy of the power, prestige and position of the nation or the individual. Foundrymen's associations in France, Belgium and England have sent personal representatives to present annual exchange papers before recent conventions of the American Foundrymen's association and it is cause for gratification to American foundrymen to learn that such a large number of members are taking advantage of the invitation so graciously extended by their European confreres to visit their respective countries during August and September of this year.

The soldiers of the four nations presented a united front to the common enemy. They marched shoulder to shoulder. They shared the honors and filth in the muddy trenches. Under a cloud of bursting shells they fraternized and swapped jokes and cigarets in convenient shell holes in the devastated area known as no man's land. In grim and silent array they swarmed over the top on innumerable occasions. They learned the art of war from each other and in a baptism of blood washed away ancient insular traditions and missunderstandings. In the light of this experience and while welded in the bonds that were forged in days of peril and privation, and ultimate victory, it is only natural that they now should meet on a common ground to promote and foster the arts of peace.

The foundry industry has made wonderful strides in the United States in recent years, but the same also is true of progress along similar lines in European countries. Local conditions and national characteristics have influenced the manner in which increased knowledge has been applied and foundrymen attending the conventions with open minds will come away with new ideas and a broadened perspective of the changing times and circumstances.

Trade Outlook in the Foundry Industry

BUSINESS, like the small boy in the dark, knows that there is no trouble ahead, but is afraid to look. Ask particularly any foundryman what he thinks of conditions and he will shake his head, look solemn and say that he is getting only small orders. Nevertheless, probably his shop is as active as the available supply of labor will permit and each day's mail brings new orders for castings. The regular mid-summer dullness is apparent in some quarters, notably among gray iron jobbing shops, but in general operations are on a higher scale than during June with inquiries plentiful.

Employment Easier

During the past few weeks, a slight improvement has been noted in the labor situation. While men have been difficult to obtain in some centers, the general condition has improved and the turnover is not so heavy as it was earlier in the season. Wages in foundry lines are slightly higher. One reason assigned for the greater number of available men, is the slackening in building construction. Although still early building construction is not so active and few new projects are being inaugurated. Many of the large centers find that high material and labor prices have acted to discourage building, particularly of residences and apartments. Commercial and industrial projects, in the main, are well along toward completion. An interesting comment on the building situation is furnished by a large manufacturer of sash weights, who reports that he is unable to meet the demand for the smaller sized weights, while the heavier types up to 30 pounds are not sought. Smaller size windows are being specified and this has led to the unbalanced condition noted. This shop is operating at about 60 per cent of capacity.

Prices of Raw Material for Foundry Use

CORRECTED TO JULY 27

Iron		Scrap	
No. 2 Foundry, Valley	$27.00	Heavy melting steel, Valley	$18.00
No. 2 Southern, Birmingham	25.00 to 27.00	Heavy melting steel, Pitts.	17.00 to 17.50
No. 2 Foundry, Chicago	28.00 to 28.50	Heavy melting steel, Chicago	17.00 to 17.25
No. Foundry, Philadelphia	25.75 to 26.13	Stove plate, Chicago	16.50 to 17.00
No. 2 Foundry, Buffalo	25.00	No. 1 cast, Chicago	22.50 to 23.00
Basic, Valley	25.00	No. 1 cast, Philadelphia	20.00 to 21.50
Basic, Buffalo	25.00	No. 1 cast, Birmingham	20.00 to 21.00
Malleable, Chicago	28.00 to 28.50	No. 1 cast, Buffalo	19.50 to 21.50
Malleable, Buffalo	25.00	Car wheels, iron, Pittsburgh	19.00 to 19.50
Coke		Car wheels, iron, Chicago	20.50 to 21.00
Connellsville foundry, coke	5.00 to 5.75	Railroad malleable, Chicago	22.50 to 23.00
Wise county foundry, coke	7.00 to 7.50	Agricultural mal., Chicago	21.50 to 22.00
		Malleable, Buffalo	20.00 to 21.00

Steel Orders Drop

Sales of steel castings in June totaled 84,878 tons, which is 4615 tons below the total of 89,493 tons for May and a decided drop from the high March total of 143,564 tons. Of course, the former figure was abnormal as it represented the results of a backed-up demand. These figures, compiled by the department of commerce in co-operation with the Steel Founders' society, show that during June the bookings of steel castings represented 87.6 per cent of available foundry capacity. Railway specialties made a decidedly better showing with a total of 42,773 tons book, marking 111.8 per cent of capacity in this class of work. During the past six months, the effect of the heavy railway requirements is evident, with an average of 47,551 tons per month of steel castings ordered for railway service, from a group of foundries having a total capacity of 38,300 tons per month. This shows the demand to have been 124 per cent of available facilities for steel railway castings production. Cast iron pipe producers are not seeking further tonnage, as most of them are booked full for the remainder of the year and deliveries are deferred.

Rail Needs Continue

Railway requirements continue to be an important factor in the castings market. While new equipment orders have been withheld, largely due to the fact that freight car shops are booked to capacity, repair and conversion work is heavy. Box cars are being rebuilt into stock cars, and gondolas are being converted into flat cars, as need prompts. Shipments of locomotives in June total 232, and of these 221 were placed in service on lines in this country. The production for June this year was more than twice as great as that reported for the same month last year. The six months total of locomotives completed is 1405, compared to 362 for the first half of 1922. Inquiries for freight cars and locomotives alike are active. Despite pessimistic forecasts, automobile manufacture continued at a high rate through July. While some manufacturers find that orders for open type passenger automobiles are slackening, many are unable to keep up with the demand for closed cars. The total production of all classes of automobiles during June was 376,882, compared with 393,192 for the previous month. The total production for all classes of automobiles during the first six months was 2,025,965, compared with 1,150,983 for the same period last year. Automotive foundries are busy, some being booked for the remainder of this year and the early part of next. Foundry operations in June as reported by the Ohio State Foundrymen's association stood at 81.27 per cent of normal, compared to 81.12 per cent for May. This covered the gray iron foundry members of the association. Nonferrous operations stood at 77.25 per cent in June, compared to 72.13 per cent for the preceding month. Despite the fact that buying has been on a hand-to-mouth basis, the stocks of pig iron and scrap on hand increased from 82 per cent in May to 87 per cent in June. Buying is on a spot basis practically without exception. Malleable foundries are operating at 64 per cent.

Nonferrous Active

Brass and aluminum shops making castings for automotive lines are busy, while the demand for plumbers goods continues strong, despite slackening in building construction. Prices for nonferrous metals, based on New York quotations in the *Daily Metal Trade* of July 27, follow: Casting copper, 14.25c to 14.37½c; electrolytic copper, 14.62½c to 14.75c; Straits tin, 38.87½c; lead 6.50c to 6.62½c; antimony, 7.25c to 7.50c; aluminum, No. 12 alloy, open market, 22.00c to 23.00c. Zinc is 6.20c, E. St. Louis.

Comings and Goings of Foundrymen

GEORGE Kimball Burgess, director of the United States bureau of standards has been nominated for president of the American Society for Steel Treating. Mr. Burgess was born in 1874 and received his early education in his native city of Newton, Mass. He received his first degree from the Massachusetts Institute of Technology where he was instructor in physics for two years following his graduation. Later he went to Paris, France, where he completed his graduate work and received the degree of doctor of science at the University of Paris. Upon returning to the United States he became instructor at the University of Michigan for one year and at the University of California for two years, after which he went to Washington and entered the bureau of standards as associate physicist, in which capacity he continued until his appointment as director of the bureau in April of this year. Dr. Burgess always has shown a keen interest in pyrometry and has never missed an opportunity to emphasize the necessity for accurate thermal control in modern metallurgical operations. He has contributed papers generously to the numerous scientific societies. He is a member of the American Society for Testing Materials of which he now is president; the National Academy of sciences; the American Institute of Mining and Metallurgical Engineers; Iron and Steel Institute of Great Britain; the Washington Academy of Sciences and the Philosophical Society of American Society for Steel Treating. Washington of which he is past president the French Physical society and the He is chairman of the board of federal specifications of the bureau of the budget and is a member of the National Research council. He also represents the United States department of commerce in dealing with the preparation of standards of engineering materials and practices in connection with the work of the American Engineering Society committee.

H. J. Perkins has been made works manager of the Niagara Falls Smelting & Refining Corp., Buffalo, N. Y. Mr. Perkins formerly was with the Sunnyside Bronze Foundry and later with the Delta Foundry Machine Co.

E. O. Haskens, for the past two years manager of the Birmingham plant of the American Radiator Co., has been transferred to the Bayonne, N. J., plant of the company. Frank J. Sellers of the Detroit plant has been placed in charge of the Birmingham works.

W. O. Renkin, of Quigley Fuel Systems, Inc., New York, just has returned from a trip to Europe.

D. E. Cunningham has been appointed purchasing agent of the Detroit Foundry Co., Detroit, succeeding J. H. Barron,

GEORGE KIMBALL BURGESS

resigned. Mr. Barron has become connected in an official way with the Motor Machinery Castings Co, which has taken over the property of the Liberty Foundry Co.

Stephen L. Carroll recently resigned his position as superintendent of the George B. Limbert & Company, East Chicago, Ind. with whom he was connected for several years, to become general superintendent of plants for the Calumet Foundry and Machine Company, East Chicago, Ind.

W. J. Leighner has been appointed works manager of the George Cutter Co., South Bend, Ind., a subsidiary of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mr. Leighner was born in Delmont, Westmoreland county, Pennsylvania, in 1886. At the age of 15 he started to work for a grocery firm in Wilkinsburg, Pa., advancing from the position of driver to clerk. In 1903 he obtained employment with the Westinghouse company at East Pittsburgh, Pa., and has been with it continuously for more than 20 years. Starting as an errand boy, he advanced, by his own efforts, from the lowest position in the organization to his present position of works manager of the George Cutter Co.

Will Participate in Paris Convention

Arthur Braid, manager of metal sales for the Metal & Thermit Corp., 120 Broadway, New York, will sail for Europe Aug. 2. He will visit his old home in Glasgow, attend the French foundry convention in September and also will visit in London, Berlin, Nice and other centers. He will be gone about 10 weeks.

Mining Engineers Will Meet in Canada

The 128th meeting of the American Institute of Mining and Metallurgical Engineers is to be held Aug. 30 at Montreal, after a tour through Ontario and Quebec beginning Aug. 20. Papers on the following subjects will be presented: "X-ray Examination of Steel Castings," by H. H. Lester; "Nitrogen in Steel," by C. Baldwin Sawyer; "Some Commercial Alloys of Iron, Chromium and Carbon in the Higher Chromium Ranges," by C. E. MacQuigg; "Some Effects of Zirconium in Steel," by Alexander L. Field; "Effect of Silicon on Equibrium Diagram of the Carbon-iron System, Near the Eutectoid Points," by H. A. Schwartz, H. R. Payne, and A. F. Gorton; "X-ray Examination of Irregular Metal Objects," by Ancel St. John.

Electrochemical Society Chooses Dayton

The American Electrochemical Society will hold its forty-fourth annual meeting Sept. 27, 28, and 29, 1923 at Dayton, O. A symposium, "Electrochemistry of Gaseous Conduction" led by Dr. Duncan McRae; a paper on recent developments in electrolytic refining, round table discussions on electric furnace brass foundry practice, organic electrochemistry, utilization of chlorine, and electroplating will compose the program.

Obituary

George A. Rentschler, 78 years old, proprietor of the Hooven, Owens & Rentschler Co., Hamilton, O., died recently at his home in that city, due to a stroke of apoplexy. Mr. Rentschler, one of the biggest figures in Hamilton business life, came from Germany with his parents when he was three years old, locating with them in Newark, N. J. In 1870 he came to Cincinnati where he became foreman of a foundry. In 1873 he went to Hamilton and built the Deuscher foundry then known as the Variety Iron Works. Mr. Rentschler, also was president of the Hamilton Foundry & Machine Co.; vice president of the Phoenix Caster Co.; treasurer of the Citizens' Savings Bank & Trust Co. and president and treasurer of the G. A. Rentschler Co. He is survived by four sons and a daughter.

William Velte, aged 74, died July 18 in his home at Mars, Butler county, Pa. For a number of years Mr. Velte had been a resident of Pittsburgh where he conducted the Velte Foundry & Machine Co. Later the concern was moved to Mars.

William T. Isaac, vice president and general manager of the Gurney Heater Mfg. Co. died at his home in Boston, June 10. He had been connected with this company for the past thirty years, advancing from a clerical position successively to secretary-treasurer, vice president and general manager. It was while holding the last position that he superintended the erection of the company's plant at Framingham, Mass.

William J. Woodside, 92 years of age, former member of Shinnick, Woodside & Gibbons foundry, Zanesville, O., died recently in that city. He was born in Baltimore in 1831 and removed to Zanesville with his parents in early youth. At the age of 17 he became an apprenticed foundryman in the old Fracker foundry. In 1865 he became a member of Shinnick, Woodside & Gibbons, manufacturers of stoves, fire fronts, grates and other castings. In 1893 he sold his interests and retired.

Captain Hugh Moren, aged 74, director of the Duquesne National bank, the Pittsburgh Steel Foundry Co., and the Consolidated Ice Co., Pittsburgh, died at his home in that city, June 10. He was born at Freeman's Landing, W. Va., but located in Pittsburgh when a young man. In 1881, he with his brothers established the Advance Coal Co., which in 1899 they sold to the Monongahela River Consolidated Coal & Coke Co. When the Advance Coal Co., was taken over by it, Captain Moren was made master of transportation, having charge of a fleet of steamboats.

Willard Pennock, aged 70 years, president of the Minerva Steel Foundry Co., and head of the Owen China Co., died recently at his home in Minerva, O. after an illness of paralysis. Mr. Pennock nationally was known an inventor and architect, having patents on more than 100 of his inventions. He drew up plans for the first steel railway car in 1892, which was manufactured by the Pressed Steel Car Co. of Pittsburgh. He also was part owner of the Pennock Hardware Co. and had interests in the Coated Paper Products Co., both of Minerva, and in various Canton steel industries.

Charles C. Lee at one time connected with the Gisholt Machine Co., Madison, Wis., the Studebaker Corp., South Bend, Ind., and later with the Stroud Motor Mfg. Co., San Antonio, Texas, as foundry superintendent, died at Woodstock, N. B., Canada, June 26 at the age of 60 years. Mr. Lee was born and grew to manhood in the little New Brunswick town, but for over 30 years held prominent positions in various foundries in the United States. During the world war he was commissioned as lieutenant and sent with a detachment of the A. E. F. to Harbin, Manchuria, where he had charge of the foundry operated in connection with the government railway shops at that important junction point. Many readers of THE FOUNDRY will remember an interesting article which he contributed to the March 15, 1920 issue dealing with foundry and other conditions in the Far East.

Dr. Hans Goldschmidt, inventor of the thermit process for welding iron and steel and for producing high grade metals and alloys, also originator of many other inventions, died suddenly in Baden-Baden, Germany, May 20. He was born in Berlin, Jan. 18, 1861. His father was the proprietor of chemical works and tin smelter which he founded in 1847. After graduating from the "gymnasium" of Altenburg, Dr. Goldschmidt studied chemistry, physics and natural sciences in general at the universities of Berlin, Leipzig, Heidelberg, Strassburg and the Institute of Technology at Charlottenburg. In 1887 he entered the firm of Th. Goldschmidt, Essen Ruhr, Germany, in partnership with his brother, Dr. Karl Goldschmidt. The attention of the latter was applied mainly to the business management of the company, while Prof. Goldschmidt devoted himself to scientific research. His most important invention was the thermit process, now used extensively for welding iron and steel sections, and for producing metals and alloys of high purity. Prof. Goldschmidt visited this country frequently and was president of the Goldschmidt Thermit Co., now Metal & Thermit Corp., New York, from 1904 to 1916.

Volume More Important Than Pressure

Question: Air for our 18-inch cupola is supplied by a small fan comprising six 5 x 5-inch blades inclosed in a frame built of wood and tin and provided with an 8-inch opening on each side for the intake of the air and a 6-inch outlet near the bottom at one side for the discharge. This fan will not blow against pressure as I have demonstrated by closing a gate in the discharge pipe and the fan rattles along at the same old rate of speed. Could I secure a positive pressure by inclosing the fan in a cast iron shell and providing an opening at the bottom? Can you advise me how to arrange a pressure indicator for an 18-inch cupola?

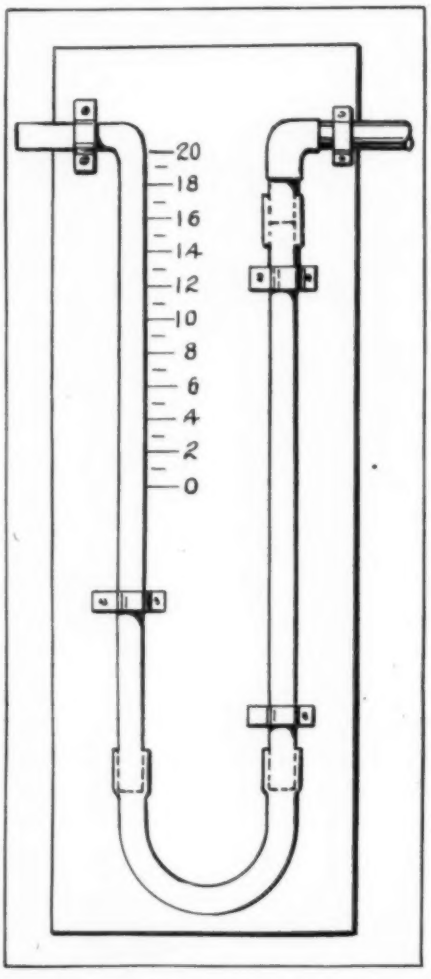
Answer: In your case and for small heats the fan is quite satisfactory. So long as the tuyeres are not choked the fan will deliver all the air you need. The terms pressure and volume are confused in the minds of many foundrymen. A given amount or volume of air is required to melt a given amount of iron in a given time. Under ordinary circumstances and with the tuyeres all open it well may be that the volume of air entering the cupola is indicated by the pressure, but when the tuyeres become choked the indicator may show the same or even a higher pressure when in reality a less quantity of air is going into the cupola.

Pressure gages can be purchased from any of the foundry supply houses or a fairly satisfactory instrument can be prepared locally as shown in the accompanying illustration. Two lengths of glass tubing approximately 0.4 inches outside diameter are joined together at the bottom with a piece of rubber tubing. The one length of glass tubing is bent over at the end and the other glass tube is connected with a 1/8-inch steel pipe formed into a right angle with an elbow. The whole is then fastened to a board. This can be done by cutting strips from a sheet of copper and using them as straps, tacking them to the board around the tubing as indicated in the illustration.

The tubes are filled to about the center with water colored with a dye or ink. This can be done by attaching a rubber to the end of the glass tube which has been bent over for this purpose, as well as to prevent

dirt from settling in the tube. The level of the water in both tubes is then marked either on the tube or on the board to which the tube is attached. Divisions are also marked to indicate ounces pressure in the tube in which the water rises with pressure. As the pressure is exerted through the side connected with the steel tube the water will rise in the glass tube which has been bent over.

Marks can be easily made with a narrow brush using black paint. It is well to varnish or shellac the board after it has been marked. As the pressure of one ounce requires a water head of 1.73 inches and as one column of water in the gage rises as the other falls an ounce pressure will be registered on the one arm in a length of ½ of 1.73 inches or 0.865 inch. Then to mark the gage distances of 0.865 inch must be laid off starting at zero. This can best be done by marking two lengths of 8.65 inches on the tube above the zero mark and dividing each of these lengths into two equal parts. Numerals can be indicated at every mark or at every second mark in which case starting from 0 the numerals would read 2, 4, 6, etc. up to 20. By this it can be seen that for a 20-ounce gage the one tube will have to be 2 x 8.65, or 17.3 inches long plus 1 inch for joining the rubber at the bottom and 3 inches for bending at the top. This would make a total length of 21.3 inches. The second glass tube could be 3 or 4 inches shorter as it is joined at the top to the steel tube. Of course, if less pressure is to be measured it would not be necessary to provide such a long tube but the longer tube prevents the liquid spilling out if pressure is raised under unusual conditions above the lower pressure expected. When the water in the tube evaporates so as to be lower than the zero mark on the tube more water must be added. Another way to keep the tube in calibration is to mark the graduations on an adjustable strip of metal or wood. Then the zero can be brought to the level of the liquid at any time the pressure is off.



HOMEMADE PRESSURE GAGE

Puts One-Piece Lining in Brass Furnace

Oil-fired brass melting furnaces of the Canadian Bronze Ltd. of Canada, Montreal, are given a one-piece lining, using crushed old brick bonded with a cement made by the Quigley Furnace Specialties Co., Inc., New York. It is stated that this type of lining gives long service, and in addition reduces the melting time from 1½ hours to 40 minutes, due to the low conductivity of the lining. Moreover, no hot metal finds its way into the joints and back of the linings to be left in the furnace after each day's run.

The illustrations show the method of preparation and application of the one-piece lining. Water is added to the cement which has been placed in the mortar box shown at the left in Fig. 1. The cement is diluted to the thickness of a pancake batter. The method of mixing the lining follows:

The refractories from old furnace linings which frequently find their way to the scrap heap, are crushed to pass ¼-inch mesh. This material, including the fines, is then added to the batter of temperature resisting cement and thoroughly mixed, using a garden hoe and shovel. Enough crushed brick is added to make a mixture of the consistency of molding sand. This mixture should be dry enough so that it is possible to pass it through a riddle, *R*, as shown in Fig. 1.

A wood form, *F*, the outline of which will conform to the inside surface of the lining, is made. The mixed material then is tamped in along the bottom of the furnace shell to a sufficient depth to allow the form, when put in place, to rest upon it as shown in Fig. 2.

The form is then put in place as noted and the lining material filled in between form and shell and rammed, using alternately the ball and peen end of the rammer. After the form has been removed, a fire is started in the furnace to dry the lining before applying a wash coat of the cement batter. The wash coat is applied as shown in Fig. 3 using a stiff brush.

Fig. 4 shows the complete lining for both sides of furnace. Before closing the sides, a wash coat of cement batter is applied all over the upper surface of

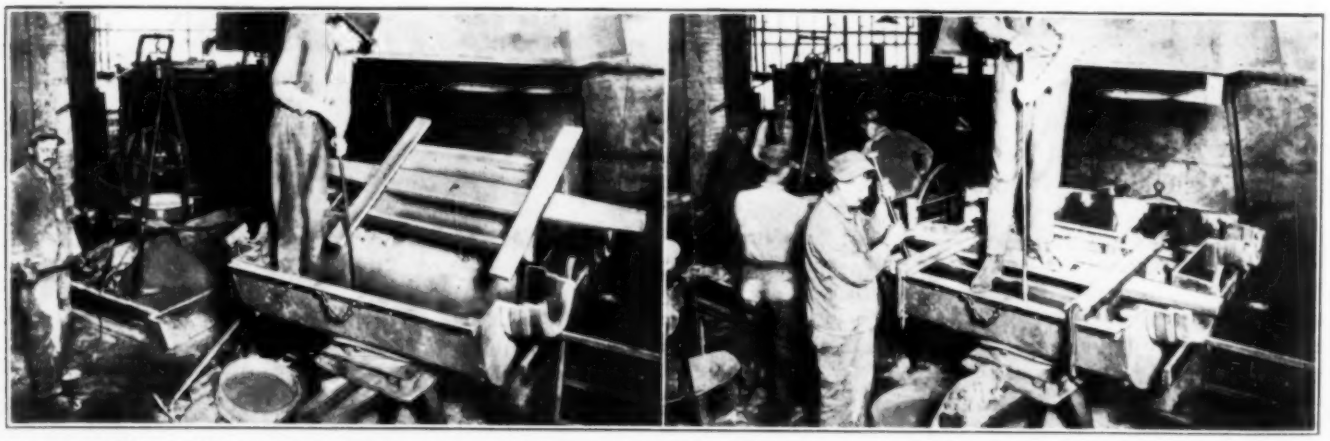


FIG. 1—AFTER MIXING THE CEMENT AND GROUND REFRACTORY MATERIAL A BED IS PREPARED IN THE FURNACE SHELL FOR THE FORM FIG. 2—WITH THE FORM IN PLACE MATERIAL IS RAMMED IN ALONG THE EDGES

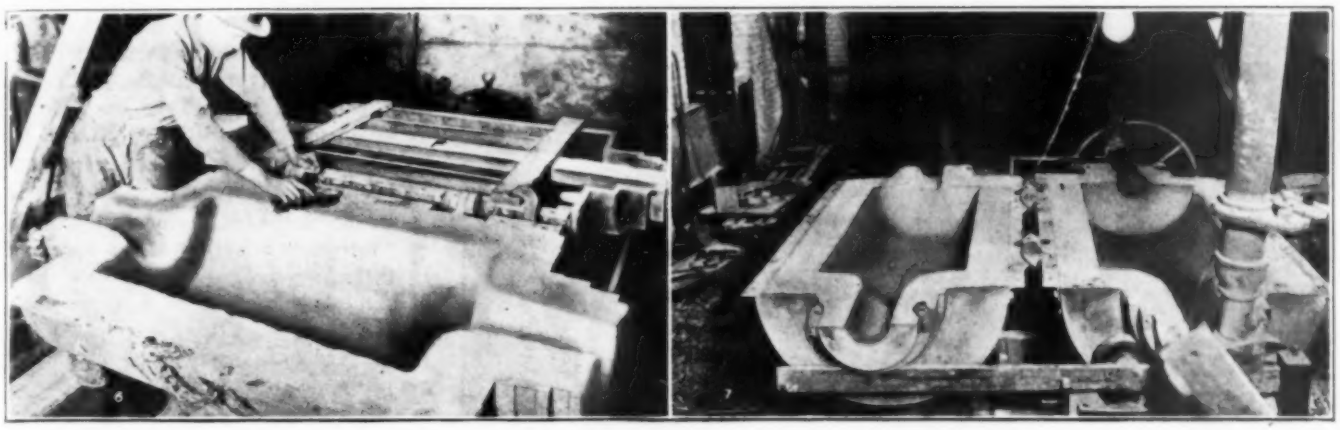


FIG. 3 AND FIG. 4—WHEN THE MATERIAL HAS BEEN RAMMED IN PLACE, THE FORM IS REMOVED AND A STRAW FIRE SERVES TO DRY THE LINING—A WASH COAT OF TEMPERATURE RESISTING CEMENT IS ADDED AND THE FURNACE IS READY TO CLOSE

both sides of the lining so that when the shell is closed, the two halves will be sealed and the lining then becomes one piece without joints at any point. After the shell has been bolted, the furnace may be put in operation at once, without injury to the lining.

Electrical Carbon Dioxide Indicator

The Bacharach Industrial Instrument Co., Pittsburgh, has put on the market a CO_2 indicator which operates on a principle entirely different from that of the chemical CO_2 indicator. It makes use of the physical property of heat conduction of the gases. The tester consists of two sets of blocks, each set of blocks containing two chambers. In the center of each chamber is a thin platinum wire, having at one end a small platinum-iridium spring for keeping the wire always central, regardless of heat expansion. The flue gas passes slowly through two of the chambers and the two other chambers contain air at room temperature. The electrical system is arranged in a Wheatstone bridge circuit, of which the four branches are the four platinum wires in the two blocks. Across the mid points of the bridge is connected a sensitive indicating galvanometer. If desired a recording galvanometor, which may be placed at any reasonable distance from the measuring instrument, can also be connected into the circuit. The electrical energy is obtained from a small storage battery through a variable resistance which is adjusted to give constant current through the ammeter.

The flue gases consist of carbon dioxide, (CO_2), carbon monoxide (CO), oxygen, nitrogen, and water vapor, with traces of other gases. Nitrogen, oxygen, carbon monoxide and air have all practically the same heat conductivity, but CO_2 has 40 per cent less conductivity, and water vapor has a conductivity about 30 per cent greater than that of air. The air in the comparison chamber is kept free from water vapor by the presence of hydroscopic chemicals, and the flue gases having passed through a cooler, which also acts as a dryer, contain a small, but practically constant, quantity of water vapor, hence the only variation occurring in the heat conductivity of the gases depends directly on the percentage of CO_2 in the flue gas.

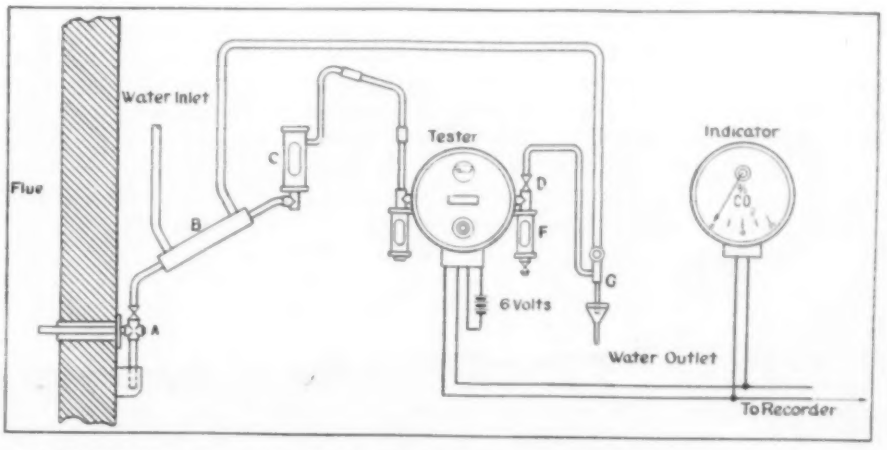
As the electric current flows through the platinum wires, the heat which is generated in them is transmitted through the gases to the walls of the chambers. The gases containing CO_2 transmit the heat less readily than the air and therefore the wires in the CO_2 chambers become hotter than the wires in the chambers filled with air. This increases the electrical resistance in the hotter wires unbalancing the circuit and causing a deflection of the galvanometer, to an extent depending on the percentage of CO_2 present. The galvanometer is calibrated to read directly in per cent of CO_2.

In this meter, time lag is practically eliminated. The interval between drawing the gas into the sampling tube and the indication of its CO_2 content never exceeds 2 minutes. The accuracy of the indication is guaranteed within plus or minus ½ per cent of CO_2.

In practice some accessories are required for auxiliary purposes such as cleaning the gas sample and for drawing it through the measuring instrument. The accompanying illustration shows diagrammatically the general arrangement.

The flue gas sample is drawn through the tube *A* to the cooler *B*, in the outer jacket of which circulates water going to the aspirator *G*. From the cooler, the gas goes through the soot filter *C*, then to the measuring instrument. From this tester the gas passes to the aspirator *G*. The latter is connected with the cock *D*, above the manometer *F*, to produce a suction of about 1 inch water column above the flue draft, thus insuring a practically constant rate of gas flow. Under these conditions the gas flow will be fast enough to insure a reasonably quick change of sample but at the same time the flow will not be so fast as to influence the heat transfer from the wire.

Indications given by the instrument, with conditions of fairly constant load



ARRANGEMENT OF THE CARBON DIOXIDE INDICATOR WITH AUXILIARY APPARATUS

THE TESTER RESTS ON A BALL AND THE HARDNESS OF THE SURFACE IS MEASURED BY THE LENGTH OR THE TIME OF OSCILLATION

and quality of fuel, are said to be sufficient for maintaining high efficiency of combustion, provided tests have been made with an Orsat apparatus to determine the most economical percentage of CO_2. However, when both the load and the fuel quality are exceedingly variable, the percentage of CO_2 which at one rate of firing or with a given fuel is most economical, may not correspond to the most efficient combustion with a different fuel or rate, on account of the loss caused by the production of CO. For these special cases, an electrical CO meter has been developed by the Bacharach company. This instrument can be used simultaneously with the CO_2 meter, but operates on an entirely different principle.

Hardness Tester in Form of Pendulum

Edward G. Herbert, Ltd., Atlas Works, Levenshulme, Manchester, England, has developed and put on the market a new hardness tester, shown in the accompanying illustration. The instrument is built on the pendulum principle. A ball, 1 millimeter in diameter, is held in a chuck in the center of the instrument and six screwed weights are provided for adjusting the center of gravity of the whole instrument to coincide with the center of the ball which is made of ruby or steel. The instrument is made in two weights, 2 and 4 kilograms, respectively. The pendulum of both instruments is 12 inches long and will span a surface 6 inches wide, or cylindrical articles 8 inches in diameter.

Immediately above the ball is a graduated weight mounted on a screw. By raising or lowering this weight the center of gravity of the instrument can be brought to a predetermined distance above or below the center of the ball. The graduations on the weight show displacements of the center of gravity in hundredths of a millimeter. A curved tube and bulb, and a scale graduated from 0 to 100, are fixed at the top of the instrument.

If the center of gravity is below the center of the ball the equilibrium is stable. The instrument constitutes a pendulum oscillating about its central position, the time of oscillation being greater as the length of the pendulum (the distance between the center of gravity and the center of the ball) is less. For standard tests the length of the pendulum is 0.1 millimeter (0.0039 inches) and the time of a single swing on an extremely hard surface is 10 seconds, and on a soft surface is less. Thus the time required to make 10 swings on glass is 100 seconds, on soft steels 20 to 40 seconds and on lead 3 seconds.

Another method of testing hardness with this instrument is known as the scale test. If the instrument is tilted to the right until the bubble comes to 0 on the scale, and is placed on a hard surface, it will swing pendulum fashion, the oscillations gradually decreasing in amplitude owing to the expenditure of energy at the point of contact between the ball and the hard surface. The amplitude of oscillation is shown by the bubble and scale. The position of the bubble on the scale at the end of the first swing shows the work done by the ball on the specimen and measures its hardness. The deeper the penetration of the ball into the surface the more work will be required to move the pendulum, and therefore the softer materials will allow the pendulum to swing less than harder surfaces.

Each of these tests has a scale of hardness numbers from 0 to 100, but the hardness number of a given substance are not the same on both scales.

Malleable Association Meets in East

The annual convention of the American Malleable Castings association was held at the Providence Biltmore hotel Providence, R. I., July 17 and 18, with an attendance of about 100 delegates from various sections of the country. At the business session held on the second day, interest centered on the discussion of technical problems and tests. President R. R. Fauntleroy, Moline Malleable Iron Co., St. Charles, Ill., presided. In the afternoon the members visited the plant of the Rhode Island Malleable Iron Works, Hillsgrove, R. I. Some of the guests also took part in a golf tournament. The first day was given up to entertainment, which included a Rhode Island clambake at the Hummocks, followed by a sail to Newport. The convention closed with a banquet, the principal speaker being Congressman Frank L. Greene of Vermont. Harry L. Steeves, vice president of the Rhode Island Malleable Iron Works, and vice president of the association, was chairman of the general committee in charge.

The Ideal Specialty Co., Helena, Mont., James G. Bain, manager, desires to purchase small iron and steel castings and prefers to form a connection with a small foundry in the West.

Inertia Rules Summer Market

Sales of Foundry Equipment Reported Slow, Due to Seasonal Dullness— Inquiry Maintains Confidence in Accelerated Demand for Fall as Castings Production Continues

ALTHOUGH foundry activity continues with little abatement, purchases of various classes of foundry machinery has slackened. Replacement and repair orders which were heavy during the early summer have dropped away and contracts for new equipment are less frequent than before. This condition is ascribed to the usual summer dullness and manufacturers practically without exception expect a strong demand in the fall. The Albion Malleable Iron Co., Albion, Mich. has placed an order with the Grindle Fuel Equipment Co., Harvey, Ill. for a complete pulverized coal installation for firing eight 20-ton melting furnaces, five batteries of core ovens, an annealing oven and ladle drying ovens. The Southern Pacific Co., Sacramento, Cal., will install sand blast equipment made by the Pangborn Corp., Hagerstown, Md. The Studebaker Corp. of America, South Bend, Ind. has placed a contract for its complete core oven requirements for its new foundry, comprising between 30 and 40 units with Holcroft & Co., Detroit. The Skinner Machinery Co., Dunedin, Fla. is installing a 25-ton per hour, continuous sand elevating mixing machine made by the Standard Sand & Machine Co., Cleveland.

Buying Slackens In The East

FOUNDRY equipment buying in the East has shown a sharp falling off. Some sellers report business as being fairly active, but there is little doubt the situation generally is slower. However, sentiment remains strong. Sellers describe the situation as seasonal, and look for a revival this fall. This latter anticipation is supported by the number of new foundry projects under contemplation and by the continued healthy condition throughout the metal working industry generally. Prices reflecting this sentiment continue strong all down the line; in fact, in some lines of sand blast equipment advances have been made. Included in prospective work, expected to result in the substantial buying are, a foundry extension for the Wheeler Engineering & Condenser Co., Carteret, N. J., a brass foundry addition for the Shelby Foundry Co., Shelby, N. C., the general contract having just recently been placed; and an addition for the Walker Stewart Foundry Co., Southington, Conn., costing including equipment, around $60,000. Recent buyers include the Charles Parker Co., Meriden, Conn., and the Alaska Freezer Co., Winchendon, Mass., both of which have bought cupolas from the Whiting Corp., Harvey, Ill. The Norfolk & Western railway is also understood to have recently purchased one or two foundry equipment items. No action has been taken by the Seaboard Air Line on its list of foundry equipment which includes a cupola. The American Car & Foundry Co. has recently purchased a number of ladles. The Malleable Iron Fittings Co., Brantford, Conn. which is constructing a new steel foundry has contracted for dust arresting equipment with the W. W. Sly Mfg. Co., Cleveland. Other purchasers of dust arresters and sand blast machinery from the Cleveland firm include the Singer Mfg. Co., Elizabethport, N. J., the General Electric Co., West Lynn, Mass. which has ordered four sand blast rooms and the Hunt-Spiller Mfg. Corp., South Boston, Mass. The Summit Foundry Co., Geneva, N. Y. recently has ordered a complete room-type sand blast and dust arrester installation from the Pangborn Corp., Hagerstown, Md. Other purchasers of equipment from the latter firm include the Skillman Hardware Mfg. Co., Trenton, N. J. and Ingram Rirchardson Co., Bayonne, N. J. The International Motor Co., New Brunswick, N. J. is installing sand elevating and mixing machinery built by the Standard Sand & Machine Co., Cleveland.

Slight Lull Appears In Chicago Market

EQUIPMENT manufacturers in Chicago district report conflicting conditions in the market, some noting falling off in business from that reported two weeks ago, but other interests have found better inquiry and a healthy continuation of actual orders. Crane inquiry is exceptionally good at present, including eight or ten prospects well scattered throughout the country. Molding machines have been in fair demand. Allis-Chalmers Mfg. Co., Milwaukee took a large jolt roll-over machine from Henry E. Pridmore, Chicago. Other sales by the latter firm include a roll-over machine for Standard Malleable Castings Co., Terre Haute, Ind., and a stripping plate machine for the Ford Motor Co. Sand mixers are moving freely. Business is good in miscellaneous equipment such as repair parts, compressor tanks, flasks and wheelbarrows. Apparently there is a little better feeling among foundries and more disposition to lay in equipment for the fall. Sand blast equipment sales have been fairly active. Recent purchasers of this class of machinery from the Pangborn. Corp., Hagerstown, Md. include the Illinois Malleable Iron Co., Chicago, the Packard Motor Car Co., Detroit and the Union Brass & Metal Co., St. Paul. Frank D. Chase, Inc., Chicago, in charge of the construction of a new foundry for the Burnham Boiler Co., Lancaster, Pa. has placed a contract for sand preparing machinery with the Standard Sand & Machine Co., Cleveland. The National Malleable Castings Co., has purchased a sand blast room from the W. W. Sly Mfg. Co., Cleveland, for use at its Indianapolis plant.

Small Sales Predominate In Pittsburgh

PRESENT trading on foundry equipment in the Pittsburgh area lacks snap and vigor. This in measure is traced to the mid-summer dullness, but surveys among foundries bring to light the fact that not as much business is being closed as in the second quarter. Consequently there is less call for new equipment since present complements of machinery cannot be kept entirely active. From time to time flasks and wheelbarrows as well as other small supplies are purchased as needs arise although in connection with flasks, orders now are not for as many as usually are bought at one time. During the past week or two buying of molding machines likewise has fallen off considerably although prior to that time there ensued a good buying movement. Orders, for instance, taken by the Herman Pneumatic Machine Co., Zelienople, Pa.,

were mostly for single machines the list of purchasers including the following: Twin City Forge & Foundry Co., Stillwater, Minn.; Burnham Boiler Corp., Lancaster, Pa.; Union Switch & Signal Co., Pittsburgh; Ohio Steel Foundry Co., Lima, O.; Gensington-Davis Corp., Buffalo; International Heater Co., Utica, N. Y.; Weil-McLain Co., Michigan City, Ind.; American Woodworking Machine Co., Rochester, N. Y.; Niagara Radiator & Boiler Co., North Tonawanda, N. Y.; Toledo Steel Casting Co., Toledo, O.; Dagen & Rogers Steel & Iron Co., Crumlin, Pa.; South Side Foundry & Machine Works, Charleston, W. Va.; Wheeling Bronze Casting Co., Wheeling W. Va.; Oil Well Supply Co., Oil City, Pa.; Charles Wamsley Co., Ltd., Montreal, Quebec, and the Josiah Anstice Co., Inc., Rochester, N. Y. These all bought one machine each while the National Car Wheel Co., Rochester, N. Y., the Michigan Valve & Foundry Co., Detroit, bought two. Acme Steel Co., Glassmere, Pa. will install sand blast and dust arrester equipment made by the Pangborn Corp., Hagerstown, Md. The Krupp Foundry Co., Lansdale, Pa. has ordered a dust arrester from the W. W. Sly Mfg. Co., Cleveland.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The May Tray Corp., York, Pa., contemplates the erection of three foundry buildings.

A 1-story foundry building is being planned by the Florin Foundry & Mfg. Co., Florin, Pa.

The Delaware Brass Co., Delaware, O., has had plans prepared for the erection of a 1-story factory building, 50 x 150 feet.

The Chase Metal Works, Waterbury, Conn., plans the erection of a 1-story plant addition, 30 x 72 feet.

Erection of a 1-story plant building, to be 40 x 100 feet, is planned by the Shelby Foundry Co., Shelby, N. C.

The Frank Foundries Corp., Moline, Ill., is erecting an addition to its plant at an estimated cost of $20,000.

The Jamestown Malleable Products Co., Jamestown, N. Y., Tiffany avenue, plans the erection of an addition to its plant.

The plant of the Dayton Steel Foundry Co., Broadway and Miami Chapel road, Dayton, O., recently was damaged by fire.

The Wincroft Stove Works, Middletown, Pa., is reported considering the erection of a new plant building.

The Climax Engineering Co., Clinton, Iowa, contemplates the erection of a foundry building.

The Rochester Foundry & Machine Co., Rochester, N. H., plans to rebuild the portion of its plant recently damaged by fire.

Erection of a foundry building is contemplated by the Essex Brass Foundry Co., Cambridge, Mass.

The Damascus Brake Beam Co., Cleveland, has been purchased by the American Steel Foundries, Chicago.

The Walker-Stewart Foundry Co., Southington, Conn., plans the erection of a 2-story plant building, to be built at an estimated cost of $50,000.

The Chantrell Hardware & Tool Co., Reading, Pa., will start work on the erection of a 1-story addition to its plant, to be built at an estimated cost of $17,000.

The Ohio State Stove Mfg. Co., Columbus, O., contemplates the erection of a 1-story addition to its plant to be built at an estimated cost of $20,000.

The Buck Stove Co., Brantford, Ont., is contemplating increasing the capacity of its present plant and installing additional equipment for the manufacture of stoves, etc.

Clare Bros. Co., Preston, Ont., has purchased the stove and furnace business of the Burrow, plans for which now are under way.
Stewart & Milne Co., Hamilton, Ont.

Severe damage was caused to the plants of the Gilson Mfg. Co. and the International Malleable Iron Co., at Guelph, Ont., by an electric storm.

Plans are being prepared by the Gem Foundry Co., 271 West Western avenue, Muskegon, Mich., for the erection of a 1-story foundry building, 60 x 100 feet, at Hart, Mich.

The Amreican Steel Foundries, Chicago, is completing the erection of an extension, 85 x 200 feet, to the cleaning room of its plant at Indiana Harbor, Ind.

The Lincoln Stove Repair Co., 205 South Tenth street, Lincoln, Nebr., plans the erection of a 1-story plant building, 100 x 140 feet, to be built at an estimated cost of $65,000.

The Iowa Foundry Co., Sioux City, Iowa, is erecting two additions to its plant, 55 x 55 feet each, and a new office structure, 25 x 35 feet.

The Iowa Malleable Iron Co., Fairfield, Iowa, is taking bids for the erection of a 2-story plant building, 27 x 64 feet, to be built at an estimated cost of $50,000.

Preparations for the opening of the Electric Auto Light foundry near the main plant of the company in the north end of Fostoria, O., are being pushed. J. R. Lester will be superintendent of the plant.

Contract has been let by the American Skein & Foundry Co., Racine, Wis., for the erection of a 2-story plant addition, 42 x 140 feet, to be built at an estimated cost of $40,000. A cupola will be installed.

Plans are being drawn for the construction of a manufacturing plant at Washington, Ind., for the Leonard Range Co., Indianapolis. The building will cost approximately $100,000 and will be of brick, reinforced concrete and steel construction.

The Bennett Brass Co., Greenville, Mich., recently was formed with a capital stock of $150,000 to operate the brass plant at Greenville which has been in the hands of a receiver for more than three years. Willard J. Bennett, Manufacturers building, is one of the incorporators.

Eberhardt & Wagner Co., 2357 Elston avenue, Chicago, has been incorporated with a capital stock of $5000 to engage in a general foundry business, by Otto Wagner, Ella Eberhardt and Fred Eberhardt. The company is represented by Frank T. Tolkuehn, 1109, 69 West Washington street.

Fire originating from lightning totally destroyed the Riverview Foundry Co.'s plant at Silver Lake, Wis., near Kenosha, recently. It was built in 1916 and was used largely for manufacturing stoves and ranges. The loss is in excess of $60,000. It will be rebuilt as soon as adjustments of insurance are made. R. M. Dixon is general manager of the company.

A. A. Wickland & Co., Chicago, have taken the contract to furnish all equipment needed for a large addition to the foundry of the Belle City Malleable Iron Co., at Racine, Wis. The building will be 290 x 360 feet, but only the first unit, 115 x 306 feet, will be erected this year, work on the remainder to be started in March, 1924. C. S. Anderson is general manager.

Work has been started on construction of the first unit at the plant of the A. C. Williams Co. foundry, Ravenna, O. The first unit is a series of concrete pits above on which a railroad siding is to be laid so that cars can be run directly over them for unloading. The building will be used for the storage of sand and is to be of steel and concrete. Two additional structures will be erected this summer.

New Trade Publications

GRINDER AND BUFFER—The Hisey-Wolf Machine Co., Buffalo, has published a circular describing an electric combination grinder and buffer constructed for both alternating and direct current. The machine is constructed for practically any voltage, although the alternating are a standard 60 cycle. A distinguishing feature of the grinder is the encased spindle connected to the motor armature by a suitable clutch.

ELECTRIC FURNACES—The use of small resistance furnaces, for laboratory use with cross-sectional views is presented in a small booklet prepared by the Norton Company, Worcester, Mass. This company specializes in refractories for use in making linings in furnaces. Attention is given to the combustion, tube and muffle type of furnace as well as the use of the more common resistors, such as platinum, tungsten, molybdenum and carbon. Brief attention also is given to the subject of temperature control.

STEAM DRIVEN COMPRESSOR—A 36-page bulletin has just been published by the Ingersoll-Rand Co., New York, in which it describes steam driven air compressors, of which four different types are described. Particular attention is called by the manufacturers to the automatic cut-off governor which regulates the compressor. The governor is designed to maintain constant air pressure regardless of demand, to regulate the steam cut-off to take care of varying steam conditions, to adjust the speed of the compressor to the demand for air and to prevent the compressor from exceeding a maximum safe speed.